Management of the California State Water Project

Appendix E
2002 Water Operations in the Sacramento-San Joaquin Delta

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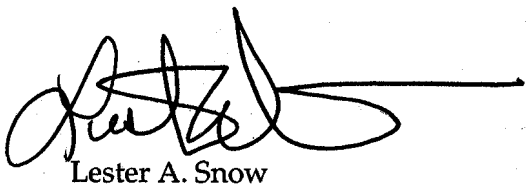
FOREWORD

This is the twenty-eighth edition of Appendix E, Bulletin 132, *Water Operations in the Sacramento-San Joaquin Delta*, an annual publication written for the State Water Project contractors, resource agencies, the State Water Resources Control Board, and other regulatory agencies. Appendix E documents SWP operations in the Sacramento-San Joaquin Delta, in addition to reporting on Delta water quality. SWP operations are modified to meet water quality standards and flow requirements, as well as environmental and other operational constraints.

The Sacramento-San Joaquin Delta has often been called the focal point of water resources development in California's Central Valley. The Delta is the collection point for State Water Project water delivery to the San Francisco Bay Area, the San Joaquin Valley, and Southern California. Thus Appendix E is designed to document significant Delta events as well as to review overall performance of SWP Delta operations.

This report is based on the 2002 water year (October 1, 2001, through September 30, 2002), which was classified as *dry* for all beneficial uses under criteria set forth in the SWRCB's Decision 1641.



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California Water Commission

The California Water Commission serves as a policy advisory body to the Director of Water Resources on all California water resources matters. The citizen commission provides a water resources forum for the people of the State, acts as a liaison between the legislative and executive branches of State Government, and coordinates federal, State, and local water resources efforts.

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Acronyms and Abbreviations

af	acre-feet
CALFED	State and federal resource agency program coordinating Bay-Delta management activity
cfs	cubic feet per second
CL	chloride concentration
COA	Coordinated Operation Agreement
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act (PL 102-575, Title 34)
D-1379	SWRCB Water Right Decision 1379
D-1422	SWRCB Water Right Decision 1422
D-1485	SWRCB Water Right Decision 1485
D-1630	SWRCB Water Right Decision 1630
D-1641	SWRCB Water Right Decision 1641
DCC	Delta Cross Channel
Delta	Sacramento-San Joaquin Delta
DFG	Department of Fish and Game
DO	dissolved oxygen
EC	electrical conductivity (also referred to as specific conductance)
ESA	California Endangered Species Act
EWA	Environmental Water Account
FERC	Federal Energy Regulatory Commission
FESA	federal Endangered Species Act
FRSA	Feather River Service Area
IEP	Interagency Ecological Program
ISDP	Interim South Delta Program
JPE	Juvenile Population Estimate
maf	million acre-feet
NBA	North Bay Aqueduct
NDOI	Net Delta Outflow Index
NOAA Fisheries	National Marine Fisheries Service
PMI	Previous month's Eight River Index
RTM	real-time monitoring
SDIP	South Delta Improvement Program
SJRA	San Joaquin River Agreement
SRI	Sacramento River Index
SWP	State Water Project
SWRCB	State Water Resources Control Board
the Bureau	Bureau of Reclamation
taf	thousand acre-feet
USFWS	U.S. Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Plan
X2	location of 2 ppt. isohaline

1. Summary

Water Supply Conditions

Water year 2002 (October 1, 2001, through September 30, 2002) recorded 10 of its 12 months with statewide precipitation below average and the water year ended with a classification of *dry* under criteria contained within the State Water Resources Control Board's Decision 1641.

Water Supply Schedules – Actual Deliveries

On November 30, 2001, the Department approved initial Table A amounts of 824,000 af, or 20 percent of most SWP contractor requests. Above-average precipitation occurred in Northern California during December 2001, enabling the Department to increase the 2002 approved Table A amounts to 1.86 maf, or 45 percent, on January 11, 2002. Further improvements in water conditions during 2002 allowed additional increases in approved Table A amounts to 2.3 maf (55 percent) on March 22; 2.5 maf (65 percent) on May 15; and finally to 2.89 maf (70 percent) on August 26.

During 2002, the State Water Project delivered 4,061,871 af of water to 27 long-term contractors and 24 other agencies. Included in that amount are 2,573,030 af of approved Table A water; 43,089 af of Article 21 water; 26 af of unscheduled water; 3,694 af of SWP water for recreation, fish and wildlife; and 1,141,622 af of water delivered to satisfy water rights settlement agreements and agreements with SWP contractors and other agencies, including the Bureau of Reclamation.

Release of water into the Aqueduct from Avenal Gap Siphon

State Water Project Operations

During 2002, the Department and the Bureau of Reclamation operated joint projects in accordance with SWRCB's D-1641, which includes water quality, flow, and operational criteria for the estuary. Operations of the SWP and Central Valley Project were coordinated with various objectives of CALFED, the 1995 Bay-Delta Plan, Central Valley Project Improvement Act, and biological opinions for fish species listed under federal and State endangered species acts. CALFED's Record of Decision mandates an Environmental Water Account managed by the Department, the Bureau, Department of Fish and Game, and U.S. Fish and Wildlife Service for the protection of listed fish species. Real-time monitoring of fish movement and conditions in the estuary aid daily water management by providing more timely information for the protection of targeted fish species from entrainment at the Delta pumping facilities of the SWP and CVP, ensuring water supply reliability.

Lake Oroville Operations

Water year 2002 began with Lake Oroville storage at 1.5 maf (42 percent capacity and 65 percent of average). Lake Oroville inflow for water year 2002 was 2.62 maf (56 percent of average), significantly greater than water year 2001's total of 1.89 maf (41 percent of average). Lake Oroville reached maximum storage on April 28, 2002, at 2,659,224 acre-feet—about 75 percent of capacity and about 90 percent of historical average. Lake Oroville's carryover storage at the end of water year 2002 was 1.40 maf or 40 percent of capacity (83 percent of average).

Water contractors in the Feather River Service Area took water deliveries every month of 2002 except February and March, for a total of 1.13 maf. Some of the water from these diversions is returned to the Feather River in the form of agricultural runoff.

Water released from the Oroville-Thermalito Complex augments the flow of the Feather and Sacramento Rivers whereas retention of water reduces downstream river flow. Mean monthly river flow was augmented from May through November, with the highest augmentation occurring during July and August. River flows were reduced during high reservoir inflow periods which occurred from January through April and in December. The greatest reductions in river flow occurred in January.

Delta Operations

SWP operations affect the Sacramento-San Joaquin Delta in many ways, all of which are taken into account: high winter and spring inflows are reduced; Delta outflow can be decreased as a result of contracted water deliveries or to provide off-stream storage; Sacramento River flow and Delta outflow can be augmented during the summer and early fall months; and the Delta's natural circulation and outflow patterns can be altered.

During 2002, Delta conditions, as defined by the 1986 Coordinated Operating Agreement, were in excess for 167 days. The operators of SWP and CVP seek to balance exports with in-basin and fish and wildlife needs. Excess conditions allow greater flexibility in project operations; however, operations can be restricted during excess periods by a fish-related restriction or to balance the export/inflow ratios within set objectives. No additional restrictions were applied during 2002. Delta conditions remained in excess from January 1 through June 2, 2002, but subsequently changed to balanced conditions on June 3 and the SWP and CVP continued to operate under balanced conditions through December 17, 2002. Excess conditions were declared on December 18 and continued through the remainder of the year.

The Delta Cross Channel gates are operated in accordance with D-1641, which lists closure periods from November 1 through June 15. During the balance of the year, when the gates typically remain open, they may be closed for short periods in response to high Sacramento River flows, water quality concerns, fishery concerns, or hydrodynamic and fishery experiments. During 2002, the DCC gates were open for 194 days. They remained closed from January through

late May. The gates were opened May 24 through May 28 to allow for recreational boat passage. Following a brief closure, the gates were opened again on May 31 for 2 weeks to conduct an experiment to determine impacts to fisheries and water quality. After this experiment, the gates were opened on June 14 and remained open until mid-October.

On October 16, the gates were closed to conduct a 3-day fish study. The gates were reopened on October 19 but as the study ended, gate #2 malfunctioned and fell closed shortly after opening. Gate #2 remained closed until November 12 when both gates were closed to conduct maintenance and repairs. The repairs were completed later that same day and both gates were reopened. The gates were closed again on December 3 for a 7-day period because fish sampling found young out-migrating Chinook salmon in the north Delta. High Sacramento River flows caused the gates to be closed on December 16, 2002, and they remained closed through the balance of the year.

Flow Standards. D-1641 contains a calculation of Delta outflow known as the *Net Delta Outflow Index* and sets minimum NDOI requirements throughout the year.

During 2002, all NDOI requirements were met; the highest NDOI monthly average, 37,812 cfs, occurred in January and the lowest occurred in August with 3,586 cfs.

D-1641 also requires minimum monthly flows on the Sacramento River at Rio Vista from September through December, ranging form 3,000 to 4,500 cfs. All Rio Vista flow standards were met in 2002. Rio Vista flow fell to its lowest level in October 2002, averaging 5,628 cfs for the month.

Monthly flow minimums for the San Joaquin River at Vernalis are contained within D-1641 as well. The flow minimums are in effect from February through June and in October and vary based on water year type and the location of the X2 geographic isohaline. All base flow minimums for the San Joaquin River at Vernalis were met in 2002.

Delta Exports. D-1641 includes an export objective that limits how much water can be diverted at Tracy and Banks Pumping Plants based upon the quantity of Delta inflow. This percent of inflow-diverted objective can vary between 35 to 45 percent for February through June, depending upon the Eight River Index, and rises to 65 percent for July through the following January.

During February 2002, SWRCB allowed the percent of inflow objective to be relaxed to pump water for the Environmental Water Account.

During 2002, exports at Banks were hampered by elevated salvage of Delta smelt during May and June. In addition, compliance with Delta outflow requirements constrained exports during June through August. During October, the chloride standard at Rock Slough was exceeded eight times and exports were reduced at Banks to help alleviate the problem. Water quality concerns hampered exports in November as well. The SWP pumped 2.79 maf at Banks Pumping Plant in 2002, compared to 2.31 maf in 2001.

North Bay Aqueduct Operations

The North Bay Aqueduct conveys Delta water pumped at Barker Slough in the north Delta to contractors in Napa and Solano counties. During 2002, deliveries to the North Bay Aqueduct totaled 45,435 af, about 1 percent of total SWP deliveries.

South Delta Temporary Barriers Project

Since 1990, the Department has constructed seasonal barriers under the program's South Delta Temporary Barriers Project to improve south Delta water conditions and collect data for the design and operation of proposed permanent barriers. The temporary barriers are placed across Middle River, Old River near Tracy, Grant Line Canal, and Old River at Head.

In spring 2002, the Old River at Head barrier was operational by April 18 and was removed by June 7. In the fall, the Old River at Head barrier was operational by October 4 and was breached on November 12. The removal of the barrier was completed on November 21.

The Middle River barrier was operational by April 15 and breached on November 20. The Middle River barrier was completely removed by November 23.

The Old River near Tracy barrier was installed on April 18. The barrier was breached on November 16 and removal completed on November 29.

In 2002, the Grant Line Canal barrier was installed on June 12. The barrier was breached on November 16 and completely removed by November 25.

Delta Water Quality Standards

Delta water quality is primarily regulated by salinity objectives and flow requirements. The salinity objectives are listed as electrical conductivity or chloride maximums. These water quality objectives are designed to address the impact of seawater intrusion and agricultural drainage as affected by exports, tributary inflows, and reservoir releases.

The water quality and flow standards included in the 1995 Bay-Delta Water Quality Control Plan and D-1641 are designed to protect the beneficial uses of Delta water. The beneficial uses are categorized as Municipal and Industrial, Agricultural, and Fish and Wildlife.

The 1995 Bay-Delta Plan contains a dissolved oxygen objective requiring 6.0 mg/L or higher DO on specific stretches of the San Joaquin River. D-1641 contains EC and chloride objectives for Delta water, in addition to an estuarine habitat protection objective which requires EC of 2.64 mS/cm or Delta outflow criterion of 11,400 cfs or 29,200 cfs, dependant upon the location of X2. The 1995 Bay-Delta Plan also contains narrative objectives for the protection of salmon and brackish tidal marshes of the Suisun Bay that implicitly list measures to protect water quality.

During 2002, all agricultural and fish and wildlife EC objectives were met at all Delta and Suisun Marsh locations. The municipal and industrial chloride requirements were met at all locations with the exception of the Contra Costa Pumping Plant on Rock Slough, where the 250 mg/L objective was exceeded eight times in October 2002.

During late summer and early fall each year, DO concentrations in the Stockton Ship Channel are closely monitored because they can deteriorate to critically low levels (<5.0 mg/L). DO is measured at 14 sites, at the water surface and at the channel bottom, between Prisoner's Point and the Stockton Deep Water Channel Turning Basin.

During August and September 2002, San Joaquin River flows at Vernalis were relatively low ranging, from 1,000 to 1,626 cfs. The Old River at Head barrier was installed on October 4, 2002, in response to the low San Joaquin River flows and projected fall flows that would be insufficient to alleviate low DO conditions in the eastern channel. The barrier remained in place until November 15. Though DO levels fell below the standard at some locations prior to the installation of the Old River at Head barrier, following the barrier installation, DO levels were generally high in all channel regions.

The estuarine habitat objective (X2), in effect from February through June, can be met with a specified number of days in which average EC is 2.64 mS/cm or less at either Chipps Island or Port Chicago. The X2 objective can also be met using Delta outflow criteria, which is measured as a 3-day running average of NDOI—11,400 cfs or 29,200 cfs dependant upon whether X2 is required to be at Chipps Island or Port Chicago, respectively. During 2002, X2 was met at Chipps Island from February through June.

2. Introduction

Appendix E of Bulletin 132 documents the State Water Project's operation in the Sacramento-San Joaquin Delta as affected by Lake Oroville operations, water conditions, water demand, pumping operations, water quality standards, as well as environmental guidelines and initiatives. Additional reports relating to SWP operations that document Delta fish and wildlife studies, water quality conditions, water supply operations, and monitoring research are available by consulting the Department's Publications and Paperwork Management Office's Web site at http://www.owe.water.ca.gov/information/pubs.cfm.

The State Water Project

The State Water Project is a system of reservoirs, power plants, pumping plants, and aqueducts that makes up one of the largest water and power systems in the world. The SWP begins in Plumas County where three small reservoirs make up the project's northernmost facilities — Antelope Lake, Frenchman Lake, and Lake Davis.

Downstream from these three reservoirs is Lake Oroville, the keystone of the SWP. Lake Oroville stores water from the Feather River watershed. Contained by Oroville Dam, the tallest earth-fill dam in the Western Hemisphere, Lake Oroville is the project's largest storage facility, with a capacity of more than 3.5 maf. The map of the SWP (see Figure 2-1) identifies the major features of the SWP.

Water released from Lake Oroville flows through the Feather River and joins the Sacramento River, which drains the northern portion of California's great Central Valley and ultimately flows into the Sacramento-San Joaquin Delta. The SWP, CVP, and local agencies all divert water from the Delta.

North Delta exports are diverted at Barker Slough Pumping Plant, providing water for Napa and Solano Counties via the North Bay Aqueduct. South Delta exports are diverted at Clifton Court Forebay where Banks Pumping Plant lifts water for delivery into Bethany Reservoir. The South Bay Pumping Plant, located at Bethany Reservoir, delivers water through the South Bay Aqueduct to Alameda and Santa Clara Counties, although most of the water from Bethany Reservoir eventually flows into the California Aqueduct for delivery to points south.

The 660-mile California Aqueduct winds along the west side of the San Joaquin Valley and transports water to O'Neill Forebay and San Luis Reservoir. The Department and the Bureau jointly own the 2 maf San Luis Reservoir, which stores both SWP and CVP water.

SWP and CVP water released from San Luis Reservoir flows south through the San Luis Canal, another SWP/CVP joint-use facility. As the water continues to flow through the San Joaquin Valley, it has to be raised more than 1,000 feet by four pumping plants before reaching the foot of the Tehachapi Mountains.

In the San Joaquin Valley near Kettleman City, the Coastal Aqueduct serves agricultural areas west of the Aqueduct as well as municipal and

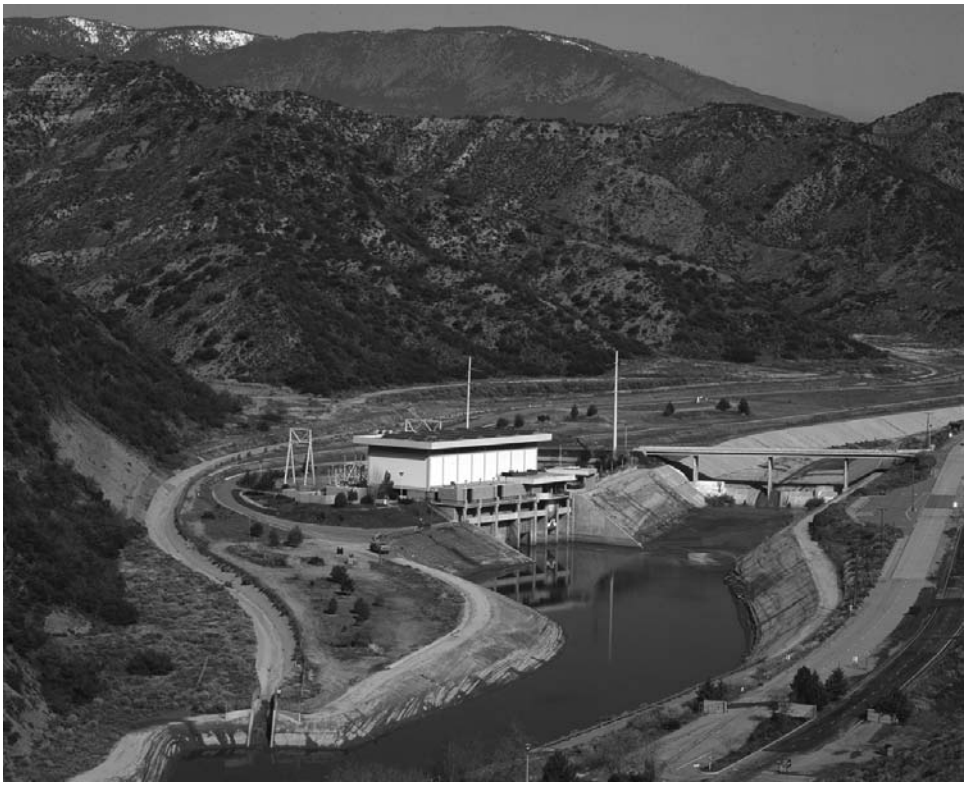
Figure 2-1. State Water Project

industrial water users in San Luis Obispo and Santa Barbara Counties.

The remaining water conveyed by the Aqueduct is delivered to Southern California, but it must first cross the Tehachapi Mountains. The Edmonston Pumping Plant, located at the foot of these mountains, raises the water 1,926 feet — the highest single lift of any pumping plant in the world. The water then flows into Antelope Valley, where the Aqueduct divides into two branches — the East Branch and the West Branch.

The East Branch carries water through the Antelope Valley into Silverwood Lake, located in the San Bernardino Mountains. From Silverwood Lake, the water flows through the East Branch to Lake Perris, the southernmost SWP reservoir. The East Branch is currently being extended and will eventually carry water from the Devil Canyon Power Plant Afterbay to Cherry Valley, bringing water to Yucaipa, Calimesa, Beaumont, Banning and other communities. Phase I will likely see completion in 2003, while Phase II is expected to be completed in 2015.

Water in the West Branch flows through the Warne Power Plant into Pyramid Lake in Los Angeles County; from there it flows through the Los Angeles Tunnel and Castaic Power Plant into Castaic Lake, the terminus of the West Branch.



Warne Power Plant, located on the West Branch of the California Aqueduct, was designed to produce and conserve energy needed for pumping water through the SWP.

3. Water Supply and Deliveries

Water Supply

Precipitation and Runoff

After a dry October, water year 2002 (October 1, 2001, through September 30, 2002) abundant storms during November and December 2001 provided precipitation well above average. During the remaining 9 months of the water year, precipitation was below average statewide and the water year ended with a classification of *dry* under criteria set forth by SWRCB.

The northern Sierra Nevada serves as California's major source of surface water. In the northern Sierra Nevada, precipitation is indexed by averaging rain gauge totals at eight representative stations creating what is known as the *8-Station Index*. The eight stations of the northern Sierra Nevada recorded 46.3 inches of precipitation (87 percent of historical average) during 2002. By comparison, water year 2001 recorded 66 percent of average. Statewide rainfall during 2002 amounted to 80 percent of average compared to 75 percent of average during water year 2001.

State records have compiled the amounts of unimpaired runoff in the Sacramento River Basin since 1906, revealing a range of 5.1 maf in 1977 to as much as 37.7 maf in 1983.

During water year 2002, the Sacramento Valley unimpaired runoff was 14.6 maf (80 percent of average) and the San Joaquin Valley unimpaired runoff was 4.1 maf (69 percent of average). Figure 3-1 illustrates the monthly precipitation totals in the northern Sierra and the historical average. October 2001 provided only 50 percent of average precipitation statewide and 57 percent of average in the northern Sierra. November and December 2001, were the most productive precipitation months of water year 2002 in the northern Sierra, providing 158 and 164 percent of average, respectively. January has historically been the most productive month of the rainy season, but January 2002 northern Sierra precipitation recorded only 5.4 inches, a mere 54 percent of average. During February, the northern Sierra was even dryer, receiving only 48 percent of average. March and April were also dryer than average in the northern Sierra, providing 81 and 55 percent of average, respectively. During the remaining months of the water year, northern Sierra precipitation was below average. On September 30, 2002 the northern Sierra precipitation totaled more than 46 inches (about 87 percent of average). Statewide precipitation amounted to 80 percent of average for water year 2002.

Snowpack

California has many snowfall watersheds that accumulate precipitation as snow during the winter months. As the snowpack melts it provides runoff from April through July. Historically, the April to July runoff from the snowpack on the western slope of the Sierra-Cascade Range provides approximately 40 percent of California's annual usable water supply.

Snowpack water content is measured monthly and reported in Department snow survey bulletins from February to May. These measurements are used to predict the seasonal snowmelt runoff, known as the *April-July forecast.* The Sacramento River Basin April-July forecast represents

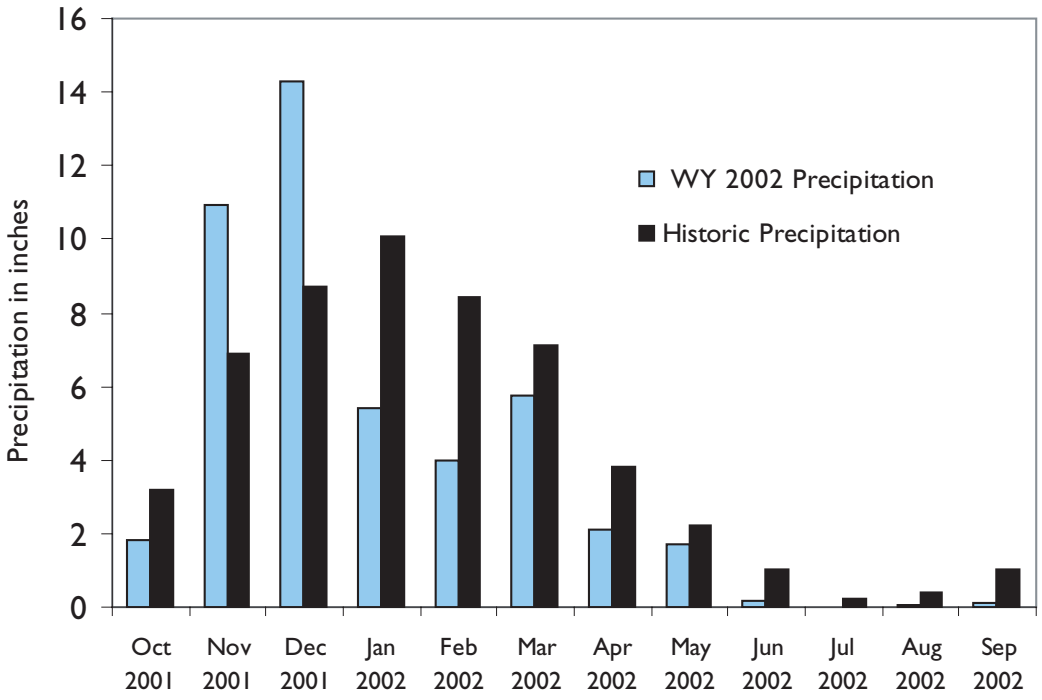


Figure 3-1. Northern Sierra precipitation average for water year 2002

natural flow conditions (unaltered by upstream diversions) that would occur in the absence of constructed dams. On May 1, 2002 Sacramento Basin April-July forecast was 74 percent of average (5.0 maf); the actual observed April-July runoff totaled 68 percent of average (4.6 maf). On May 1, the April-July forecast estimated the April-July runoff for the San Joaquin River Basin at 73 percent of average (2.8 maf), and the actual April-July runoff also totaled 73 percent of average.

California's snowpack has historically been at or near its peak on April 1 each year and is the most important factor in the prediction of seasonal snowmelt runoff. Snow accumulation in the northern Sierra during December 2001 approached the rapid pace set during the very wet 1983 water year. However, snowpack accumulations fell back closer to average in all regions by February 1, 2002. During February, the snowpack water content increased about 5 percent, considerably less than the average accumulation. On March 1, 2002, the snowpack stood at 95 percent of average compared to 85 percent at the same time in water year 2001. The snowpack reached its peak accumulation on March 25 at 95 percent of average in most areas and the snowmelt began in the warm sunny weather during the last week of March. The warm weather continued into the first part of April and produced a much greater than normal early snowmelt. By May 1, 2002, the snowpack had been reduced to 60 percent of average and continued to decrease to 45 percent of average by May 15, 2004. By June 1, snow had melted from three-quarters of the snow sensor sites and was gone from all sites by late June.

Reservoir Storage

Carryover storage in the State's 156 major reservoirs at the beginning of water year 2002 (October 1, 2001), was 19.2 maf (87 percent of average)—about 4.6 maf less than the previous water year's start. At the same time, the major reservoirs of the SWP (Oroville, San Luis, and the combined southern reservoirs) held 2.64 maf, about 0.3 maf less than at the start of water year 2001. Lake Oroville, the largest storage facility in the SWP, held about 1.5 maf,

which is about 0.4 maf less than last water year's start and about 65 percent of average.

On January 31, 2002, California's major reservoirs held 23.4 maf (99 percent of average) and SWP reservoir levels had risen to about 3.5 maf, compared to 2.9 maf 1 year earlier. Lake Oroville storage increased to about 1.9 maf, in comparison to 1.7 maf on January 31, 2001. On January 31, 2002 the State's share of San Luis Reservoir stood at 0.93 maf compared to about 0.56 maf at the end of January 2001.

Precipitation during each month from February through May was less than average. Consequently, on May 31, 2002 major reservoirs within the State contained about 28.2 maf, 75 percent of capacity and 96 percent of average. At the same time, the major SWP reservoirs held about 4.0 maf (80 percent of average) compared with about 3.6 maf on May 31 of 2001. On May 31, 2002, storage at Lake Oroville was about 2.6 maf compared to 2.1 maf at the same time last year. Lake Oroville had reached peak storage on April 28, 2002, at 2,659,217 af (75 percent of designed storage capacity). This storage peak represents the amount of water available for releases later in the year. On May 31, 2002, the State's share of water at San Luis Reservoir stood at 716 taf (there were 816 taf in the previous year).

At the end of water year 2002 (September 30, 2002), the State's major reservoirs held about 19.2 maf (86 percent of average)—the same storage that remained at the end of water year 2001. SWP major reservoirs contained about 2.47 maf in comparison to 2.65 maf at the same time last year and Lake Oroville held about 42 percent of design capacity, which is approximately 1.4 maf (62 percent of average) compared to 1.5 maf at the end of water year 2001.

Non-Project Groundwater Turn-ins

In 2001, the Department restarted a water management program to accept nonproject groundwater turn-ins into the SWP. Turn-ins are authorized during periods of reduced SWP allocations. SWP contractors, or other participants of an approved program, convey groundwater into the Aqueduct. This water may be used for local redistribution, transfer to other contractors, or exchange with the Environmental Water Account.

Turn-ins have been utilized in the past to boost available water supply during drought periods. In 2002, turn-ins not only added versatility to SWP water operations under dry-year

The San Luis Resevoir, contained by the Sisk Dam, stores Delta water for the SWP and CVP.

conditions, but also improved SWP water quality for some constituents south of Milepost 209. Turn-ins usually coincide with monthly decreases in total dissolved solids, conductivity, and organic carbon in the California Aqueduct, while slight increases in nitrate and sulfate can also result. During 2002, SWP received 36,799 af of water via the nonproject groundwater turn-ins compared to 154,972 af in 2001. The total of nonproject groundwater turn-ins in 2002 was less than 1 percent of the total volume of water conveyed by the SWP (4,061,871 af).

Floodwater

During wet years, the Department occasionally accepts floodwater from the Kern River into the California Aqueduct through the Kern River-California Aqueduct Intertie under an agreement known as the *Agreement among the State of California, Kern County Water Agency, and the Kern River for Diversions of Floodwaters through the Kern River California Aqueduct Intertie,* dated November 18, 1975. However, in 2002, the Department did not accept any floodwater into the California Aqueduct.

Water Supply Forecast Indices

Sacramento Valley

SWRCB D-1641 contains a water supply forecast tool called the *Sacramento Valley 40-30-30 Index,* which is used in the water budget operations studies as an indicator of available water supply; it replaced its predecessor, the Sacramento River Index. SWRCB uses the Sacramento Valley 40-30-30 Index for classifying types of water years and establishing a corresponding level of protection for the Sacramento-San Joaquin Delta (Figure 3-2). This water year classification system also provides estimates of the potential water supply originating in a basin from rainfall and snowmelt runoff, groundwater accretion, and reservoir carryover storage.

The Sacramento Valley 40-30-30 Index incorporates seasonal differences in water contribution for the year and includes the prior year's conditions in order to establish a more reliable index of water availability. The 40-30-30 factors represent the percentage weight given to the following:

(1) 40% — the forecasted or observed current year's April-through-July Sacramento Valley unimpaired runoff;
(2) 30% — the forecasted or observed current year's October-through-March Sacramento Valley unimpaired runoff; and
(3) 30%— the previous year's index with a cap of 10.

The Sacramento Valley unimpaired runoff sums the major flows into the Sacramento River Basin; it is also known as the *Sacramento River Index*. The Sacramento Valley unimpaired runoff for water year 2002 was 14.6 maf (76 percent of average).

The Department publishes forecasts on the Sacramento Valley 40-30-30 Index in monthly snow survey bulletins from February to May, as discussed in the section on snowpack. The May 1 Sacramento Valley 40-30-30 Index forecast determines the water year type for water quality and flow requirements contained within D-1641. Most of these water quality and flow requirements are conditioned by water year type and generally become less stringent during dryer years. On May 1, 2002, the Sacramento Valley 40-30-30 Index was forecast to be 6.5, resulting in the water year being classified as *dry* under D-1641 criteria. At the end of the water year, the actual Sacramento Valley 40-30-30 Index was 6.4 also denoting a dry water year classification (Table 3-1).

San Joaquin Valley

D-1641 also calculates a San Joaquin River Valley 60-20-20 Index (Figure 3-3) using methods similar to those in the Sacramento Valley 40-30-30 Index. The San Joaquin Valley 60-20-20 Index at the 75 percent exceedence level determine the

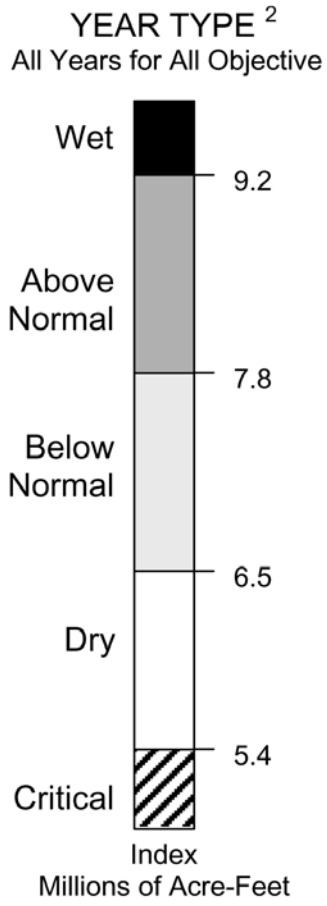
Year classification shall be determined by computation of the following equation:

INDEX = 0.4 * X + 0.3 * Y + 0.3 * Z

Where:
- X = Current year's April – July Sacramento Valley unimpaired runoff
- Y = Current October – March Sacramento Valley unimpaired runoff
- Z = Previous year's index[1]

The Sacramento Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

Classification	Index Millions of Acre-Feet (MAF)
Wet.....	Equal to or greater than 9.2
Above Normal.....	Greater than 7.8 and less than 9.2
Below Normal.....	Equal to or less than 7.8 and greater than 6.5
Dry.....	Equal to or less than 6.5 and greater than 5.4
Critical.....	Equal to or less than 5.4



1 A cap of 10.0 MAF is put on the previous year's index (Z) to account for required flood control reservoir releases during wet years.

2 The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.

Figure 3-2. Sacramento Valley Water Year Hydrologic Conditions Index

Table 3-1. Sacramento Valley Water Year Hydrologic Conditions Index, Forecast and Actual Runoff, during Water Year 2002

Date of Forecast	Sacramento Valley 40-30-30 Index Probable Exceedence			Water Year Classification[a]	State Water Contractor Allocated Annual Table A Delivery (% of Request)[b]
	50%	*90%*	*99%*		
December 1, 2001	7.0	4.9	3.9	below normal	20
January 1, 2002	7.9		5.1	above normal	45
February 1	7.4		5.3	below normal	45
March 1	6.8		5.3	below normal	45
April 1	6.7		6.1	below normal	60
May 1	6.5		5.5	dry	65
Sept 30	6.4			dry	70[c]
Actual water year unimpaired runoff		14.6 maf (76% of average)			
April-July forecast snowmelt runoff					
May 1 forecast		5.0 maf (74% of average)			
Actual unimpaired snowmelt runoff		4.6 maf (68% of average)			

[a]Probability exceedence at the median level (50%) is used to determine D-1641 water year class.

[b]Probability exceedence at the 90% level is used to forecast SWP water supply allocations in December and thereafter the 99% level is used.

[c]Annual Table A allocations were increased to 70% on August 26, 2002.

water year type for D-1641's Vernalis flow standards. The Sacramento Valley unimpaired runoff and corresponding San Joaquin Valley unimpaired runoff total are summed to produce what is known as the *Eight River Index.* This index is used to determine the duration of D-1641's habitat protection standard at Chipps Island and under specific conditions, at Port Chicago from February through June. The actual San Joaquin River unimpaired runoff for water year 2002 (including the Stanislaus, Tuolumne, Merced, and upper San Joaquin Rivers) was 4.1 maf (68 percent of average). The May 1 forecast of the San Joaquin Valley 60-20-20 Index for water year 2002 was 2.4 maf, resulting in the classification of *dry.*

2002 Water Budget Process and SWP Deliveries

The SWP satisfies percentages of long-term contractor's annual water requests within contractual agreements (approved Table A amounts) while assuring sufficient carryover storage is available to meet deliveries for Delta protection and emergencies in the following year. A balance between the State's water resources and contractor demand is met through the Water Budget Process.

This process makes annual forecasts based upon the following:

- reservoir capacity and storage at Lake Oroville, San Luis Reservoir, Lake Del Valle, and the four southern reservoirs;
- hydrology projections for the current year and future precipitation, runoff and groundwater accretion (Sacramento Valley 40-30-30 Index and San Joaquin River Valley Index 60-20-20);
- operational constraints for environmental protection, recreation/fish and wildlife; and
- demands from contractors for agriculture, municipal and industrial uses, as well as other agencies including the Bureau.

Year classification shall be determined by computation of the following equation:

INDEX = 0.6 * X + 0.2 * Y + 0.2 * Z

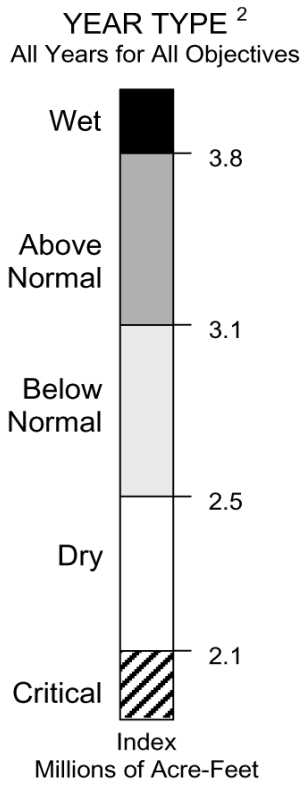
Where:
X = Current year's April – July San Joaquin Valley unimpaired runoff

Y = Current October – March San Joaquin Valley unimpaired runoff

Z = Previous year's index[1]

The San Joaquin Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Stanislaus River, total flow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total flow to Exchequer Reservoir; San Joaquin River, total inflow to Millerton Lake. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

Classification	Index Millions of Acre-Feet (MAF)
Wet……	Equal to or greater than 3.8
Above Normal…….	Greater than 3.1 and less than 3.8
Below Normal……..	Equal to or less than 3.1 and greater than 2.5
Dry……	Equal to or less than 2.5 and greater than 2.1
Critical……..	Equal to or less than 2.1



[1] A cap of 4.5 MAF is put on the previous year's index (Z) to account for required flood control reservoir releases during wet years.

[2] The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.

Figure 3-3. San Joaquin Valley Water Year Hydrologic Conditions Index

The Water Budget is an iterative water delivery allocation process. Initial allocations for the coming year are made in December and are based on operations studies that assume 90 percent exceedence of historical water supply. Exceedence refers to the probability that unimpaired flow will exceed the historical water supply. Forecasts are updated at least monthly using operations studies that begin in December; allocations are adjusted as necessary.

SWP Water Deliveries

Monterey Amendment

The Monterey Amendment was executed by the Department and the SWP's long-term water contractors on December 1, 1994. It established amendments to the Department's SWP water contracts with the long-term contractors that updated the management of the SWP by substantially revising SWP long-term contracts and their administration. It includes 14 principles that are designed to increase reliability of existing water supplies, provide stronger financial management of the SWP, and to increase water management flexibility by providing additional tools to local water agencies. No Monterey Amendments were executed during 2002.

Plumas County Flood Control and Water Conservation District and Empire West Side Irrigation District remain the only long-term SWP contractors who have not signed the Monterey Amendment.

The Planning and Conservation League filed a lawsuit on December 27, 1995, challenging the California Environmental Quality Act compliance for the Monterey Amendment. A Sacramento County Superior Court judge later dismissed the lawsuit. PCL appealed the decision and on September 15, 2000, the Third District Court of Appeal reversed the Superior Court ruling. On December 13, 2000, the California Supreme Court denied review. The parties commenced mediation on March 26, 2002, and proceedings in Superior Court were stayed pending completion of mediation. On July 18, 2002, the parties reached agreement on principles for settling the lawsuit. The Department began preparing a new EIR; the interested parties have continued mediation to convert the settlement principles into a legal agreement.

Approved Table A Water Deliveries

By October 1 of each year, the SWP long-term contractors submit their initial requests for approved Table A deliveries allocated to the contractor for use in the coming year. The initial approved Table A amounts for the subsequent year are made by the Department in December and are based on operational studies that assume 90 percent exceedence of historical water supply, current reservoir storage, and total requests by the SWP contractors. Forecasts for the year are updated as hydrologic conditions change. Approved Table A amounts can be increased or decreased based upon both actual and projected hydrologic conditions.

On November 30, 2001, the Department approved initial Table A amounts of 824,000 af, (20 percent of most SWP contractor requests). Above-average precipitation that occurred in Northern California during December 2001 caused the Department to increase the 2002 approved Table A amounts to 1.86 maf (45 percent) on January 11, 2002. Further improvements in water conditions during 2002 allowed additional increases in approved Table A amounts to 2.3 maf (55 percent) on March 22; 2.5 maf (65 percent) on May 15; and finally to 2.89 maf (70 percent) on August 26.

SWP Deliveries

In 2002, 4,061,871 af of water were conveyed to 27 long-term contractors and 24 other agencies. That amount includes

- 2,573,030 af of approved Table A water;
- 43,089 af of Article 21 water;
- 26 af of unscheduled water;
- 3,694 af of SWP water for recreation, fish and wildlife; and
- 1,141,622 af of water delivered to satisfy water rights settlement agreements and

agreements with SWP contractors and other agencies, including the Bureau.

Water Deliveries to Non-SWP Agencies

In 2002, the Department used SWP facilities to convey a total of 1,403,449 af of non-SWP water for various agencies according to terms of water rights and water transfer and exchange agreements.

CVP Water

CVP conveyed 140,507 af through SWP facilities during 2002. Conveyance was made in accordance with agreements negotiated with the Bureau and contractors receiving water from the Bureau through SWP as follows:

- Cross Valley Canal Contractors
- Kern National Wildlife Refuge
- Musco Family Olive Products, Incorporated
- the Bureau
- U.S. Department of Veteran Affairs
- Madera Irrigation District
- Westlands Water District

Water Rights Water

Water rights water is another category of non-SWP water transported through SWP facilities to long-term SWP contractors and other agencies according to terms of various local water rights agreements. In 2002, 1,141,622 af of water in this category were delivered to the Feather River and South Bay areas.

4. State Water Project Operations

The water operations data used in this report are preliminary and may not agree exactly with final figures; however, they are appropriate for use in this report. References to years are calendar years, except where noted.

Lake Oroville Operations

Operations at Lake Oroville and Thermalito Complex alter seasonal flows in the Feather River and subsequently in the Sacramento River and the Sacramento-San Joaquin Delta by retaining a portion of the winter and spring runoff for release during the summer and fall. Flood control operations at Lake Oroville occur from October through June and help lessen extreme flood peaks thereby moderating flows entering the Delta (Table 4-1).

The Department and the Bureau proportionally meet Sacramento Basin and Delta water needs through SWP and CVP operations, as specified in the 1986 Coordinated Operating Agreement. The application of COA operational measures is conditioned by flows into the Delta. Operations of both projects seek to balance exports with in-basin and fish and wildlife needs. Excess conditions allow greater flexibility in project operations; however, operations can be restricted during excess periods. A fish-related restriction applies when export pumping may impact endangered or threatened Delta fisheries. Exports are also restricted during excess flows

Table 4-1. Monthly Summary of the Oroville-Thermalito Complex Operations during 2002 (cfs)

	Lake Oroville Inflow			**Below Thermalito Outlet**						**Feather River Service Area**	
				With SWP			*Without SWP*			Mean	Mean Daily
Month	Average	Low Daily	High Daily	Average	Low Daily	High Daily	Average	Low Daily	High Daily	Diversion	Return Flow
Jan	7,072	3,134	15,308	1,310	1,200	1,388	6,705	3,122	18,863	477	110
Feb	4,297	2,585	9,332	1,200	1,200	1,200	4,297	2,811	9,332	0	0
Mar	5,681	3,799	10,140	1,200	1,200	1,200	5,681	3,799	10,140	0	0
Apr	6,320	3,732	8,187	1,390	1,200	1,865	5,685	2,595	8,143	825	190
May	3,934	2,455	5,182	2,267	1,747	3,301	2,013	1,224	2,835	2,687	766
Jun	1,811	605	3,987	3,905	1,684	5,802	473	106	2,175	2,907	509
Jul	1,315	512	2,259	6,220	5,854	6,884	158	61	271	3,107	373
Aug	1,566	468	2,310	5,275	4,277	6,012	288	82	777	2,402	420
Sep	2,119	1,097	3,337	4,415	3,966	5,040	1,791	846	3,041	993	666
Oct	1,903	638	2,803	3,164	2,754	3,524	1,349	357	2,310	1,448	811
Nov	2,441	1,391	5,141	2,386	2,311	2,537	1,268	320	3,919	1,676	386
Dec	8,393	1,568	36,985	2,151	1,939	2,381	7,468	361	36,354	1,204	277

to balance the export/inflow ratios within set objectives. During 2002, no additional restrictions were applied during 167 designated "excess" outflow days. Delta conditions during 2002, as defined by the COA, remained in excess conditions from January 1 through June 2. Delta conditions subsequently changed to balanced conditions on June 3 and the SWP and CVP continued to operate under balanced conditions through December 17, 2002. Excess conditions were declared on December 18 and continued through the remainder of the year.

Feather River Outflows

Water stored in Lake Oroville (Figure 4-1) is released through Hyatt Power Plant into the Thermalito Diversion Pool, travels through the Thermalito Diversion Dam into the Thermalito Power Canal, and then into the Thermalito Forebay. Water is released for electrical generation at the Thermalito Pumping-Generating Plant, passes into the Thermalito Afterbay and is released to several local distribution systems for use in the Feather River Service Area or flows out to the Feather River via the Thermalito Afterbay river outlet. The Feather River low-flow channel is the pre-SWP river channel; it passes downstream of the Feather River Hatchery and then merges with outflow from the Thermalito Afterbay river outlet, located 8.5 miles down river from the diversion dam. The 1983 Feather River Agreement with DFG sets minimum flow rates and specifies maximum temperatures on this low-flow channel.

Lake Oroville releases are routinely made for flood control, water supply, fish and wildlife protection, Delta water quality needs, and in response to unusual operational events. Flows are also released from the Thermalito Diversion Dam to supply the low-flow channel of the Feather River and into a pipeline supplying the Feather River Fish Hatchery.

Lake Oroville Inflow, Releases, and Storage

Water year 2002 began with Lake Oroville storage at 1.5 maf (42 percent capacity and 65 percent of average). This represents approximately 0.4 maf less than at the start of water year 2001. Lake Oroville inflow for water year 2002 was 2.62 maf (56 percent of average), significantly greater than water year 2001's total of 1.89 maf (41 percent of average).

Lake Oroville, the keystone of the SWP, reached peak storage for 2002 on April 28 with 75 percent of its capacity filled.

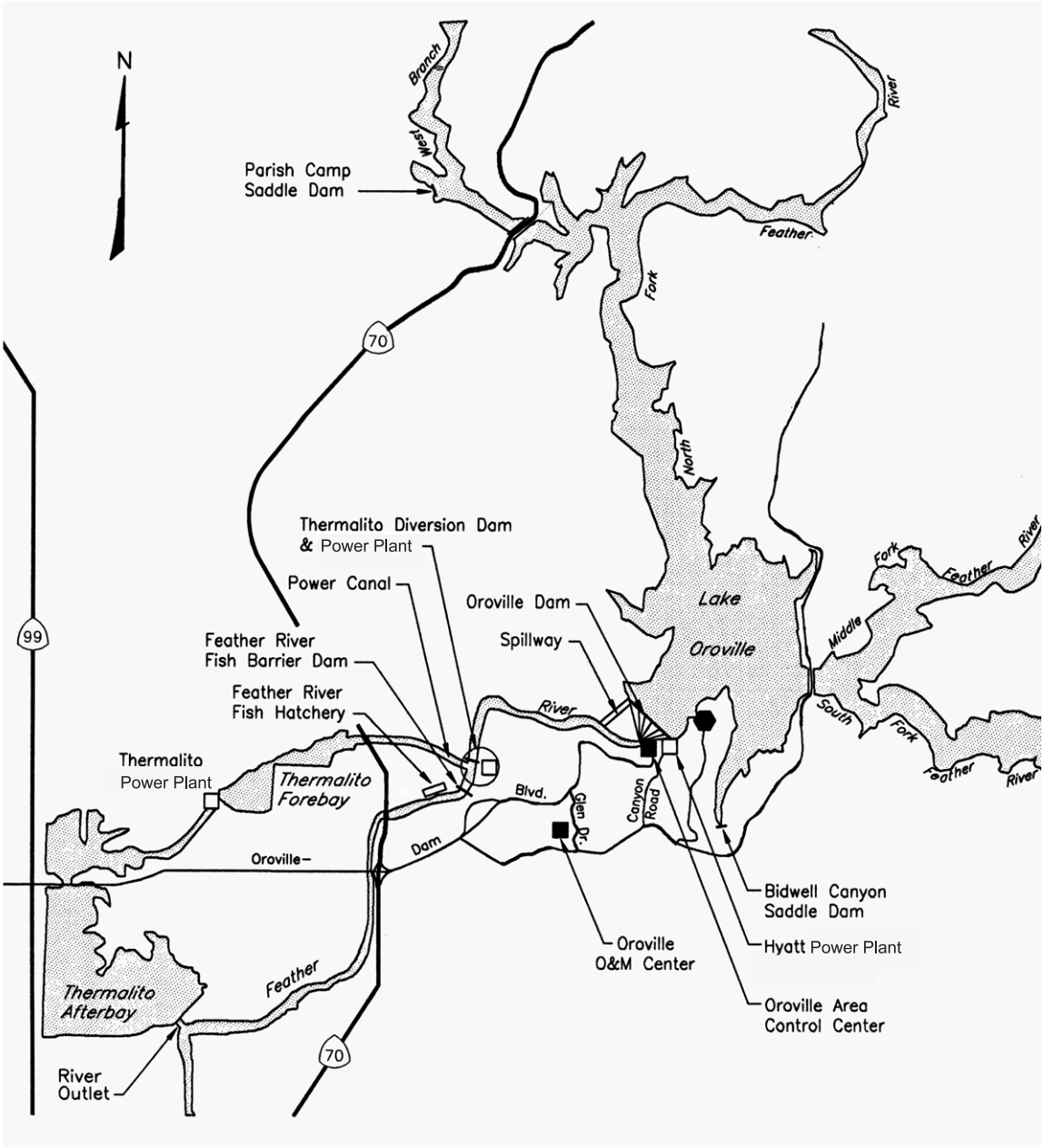


Figure 4-1. A map of the Oroville-Thermalito Complex

Though October 2001 was dry, abundant storms during November and December resulted in significant inflows into Lake Oroville during the last six weeks of 2001. Inflows during December 2001 totaled 309 taf, and increased to 406 taf during January 2002. Lake Oroville inflows declined in February to 245 taf, but increased in March and April with a total 356 taf and 368 taf, respectively. It reached peak storage on April 28, 2002, at 2,659,224 af, which is about 75 percent of capacity and about 90 percent of historical average. Inflows decreased to 239 taf in May and, as in most years, June inflows showed a significant reduction, totaling 96 taf. For comparison, June 2001 Lake Oroville inflows totaled 92 taf.

The lowest monthly inflow rate during water year 2002 occurred in July averaging only 2,680 af per day. The lowest mean daily inflow rate occurred on August 4, 2002, with an average of 929 af for the day. The highest mean daily inflow rate of 38,513 cfs occurred on January 2.

During late-November 2001, water storage at Lake Oroville began a steady climb that continued until the storage peak of April 28. Following a storage plateau that continued through May, storage declined through the end of water year 2002. Lake Oroville's carryover storage at the end of water year 2002 was 1.40 maf or 40 percent of capacity (83 percent of average) (Table 4-2 and Figure 4-2). All Feather River flow and temperature criteria set in the 1983 DFG Feather River Agreement with the Department were met in 2002.

Feather River Diversions

Water deliveries are made to Feather River area from the Oroville-Thermalito Complex for local water agencies and to satisfy water rights settlements that predate the construction of the SWP. The 2002 Feather River diversions totaled 1.13 maf and occurred during all months except February and March. The greatest amount of water was diverted during the months of May through August. Some of the water from these diversions is returned to the Feather River in the form of agricultural runoff.

Table 4-2. Lake Oroville Storage during Water Year 2002

Date	maf	Percent of Capacity[a]	Percent of Historic Average
October 1, 2001	1.49	42	65
February 1, 2002	1.92	54	79
March 1, 2002	2.13	60	85
April 1, 2002	2.42	68	87
May 1, 2002	2.65	75	89
WY peak on April 28[b]	2.66	75	90
September 30, 2002	1.40	40	61

[a]Lake Oroville has a capacity of 3,537,580 af

[b]Peak daily storage during Water Year 2002 equaled 2,659,217 af

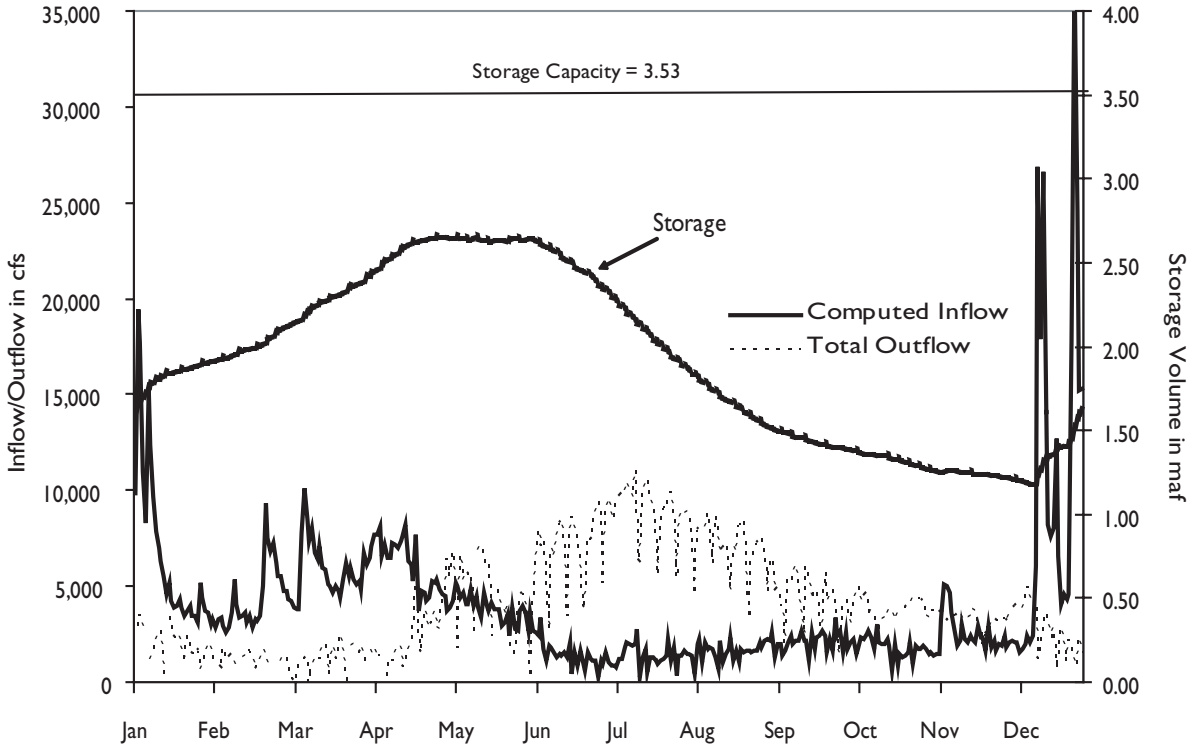


Figure 4-2. Lake Oroville inflow, outflow, and storage during 2002

Effects of the Oroville-Thermalito Complex Water Operations on Feather and Sacramento River Flow

The operation of the Oroville-Thermalito Complex affects flows in the Feather and Sacramento Rivers. However, it takes approximately 2 days for the impact to be seen in the Sacramento River below Freeport.

The Department computes a "with SWP" (current project) and "without SWP" (pre-project) flow to describe the effects of Oroville-Thermalito Complex operations on both rivers as defined below. Reservoir evaporative water losses are not included in these computations.

The sum of Oroville-Thermalito Complex releases to the Feather River plus the estimated Feather River area return flows defines the "with SWP"flow. The pre-project "without SWP" flow is calculated as Lake Oroville inflow minus deliveries to the Feather River area (up to the limit of inflow), plus return flows from the Feather River area. The difference between the "with SWP" and "without SWP" flows is the calculated effect of SWP operations on Feather River flows. Currently, most diversions to Feather River area during summer months exceed calculated pre-project Feather River flows. Under pre-project conditions without SWP, Feather River area diversions from the Feather River could not have exceeded river flow. As a result, the "without SWP" average monthly flow cannot be computed directly from Table 4-1 summary data.

Augmentation

Sacramento and Feather River flows are considered to be augmented when the water released from the Oroville-Thermalito Complex exceeds the calculated pre-project flows. Feather River flow is often augmented as a result of Oroville-Thermalito releases executed for both evacuation of adequate flood control storage capacity in Lake Oroville and to meet conditions specified in the 1983 Feather River Agreement with

DFG. Water from Lake Oroville is also released to meet Delta water quality and flow standards, ESA criteria, and SWP and non-SWP export needs at Banks Pumping Plant.

During 2002, the operations of the Oroville-Thermalito Complex augmented Sacramento and Feather River flows from May through November; as in many years, the highest flow augmentation occurred during July and August.

Reduction

Feather and Sacramento River flows are considered reduced (designated by a negative value) when flow levels fall below pre-project conditions. In 2002, flows were reduced by project operations during high inflow periods that occurred from January through April and in December. Monthly reductions were greatest during January (Tables 4-3 and 4-4, Figure 4-3).

SWP Delta Operations

Water levels and flow in the Sacramento-San Joaquin Delta are subject to sizable daily tidal fluctuations. Tidal changes in the Pacific Ocean cause flow reversal twice daily throughout much of the Delta. Flow in the Delta can also be affected by SWP and CVP pumping. SWP's Banks Pumping Plant begins the export of Delta water from Clifton Court Forebay into the California Aqueduct and nearby South Bay Aqueduct. Tracy Pumping Plant, located near Banks Pumping Plant, begins exports of CVP water into the Delta-Mendota Canal. The SWP also pumps water from the northern Delta at Barker Slough Pumping Plant into the North Bay Aqueduct.

State Water Project Operational Criteria

The Sacramento-San Joaquin Delta is an estuary and a navigable waterway subject to many Stateand federal laws that are designed to protect water quality, wetlands, anadromous and native fisheries, migratory birds, and threatened and endangered species. Table 4-5 lists the agreements, decisions, opinions, and rules that make up the institutional framework for SWP operations in the Delta. These operational criteria have a significant impact on water diversion from the Sacramento-San Joaquin Delta.

During 2002, SWRCB passed two water right orders pertaining to D-1641. Water Right Order 2002-03 denied reconsideration of D-1641 and approved a water level response plan for the south Delta. The water level response plan, prepared by the Department and the Bureau, with input from the South Delta Water Agency was

Table 4-3. Effects of SWP Oroville Operations on Feather and Sacramento River Flow during 2002 (cfs)[a]

	Months with Mean Augmentation			Months with Mean Reduction			
	Mean (+)	*Minimum Augmentation*	*Maximum Augmentation*		*Mean (+)*	*Minimum Reduction*	*Maximum Reduction*
January	254	-999	1,431	December	-5,395	-1,822	-17,498
May	3,432	-491	5,640	February	-3,097	-1,385	-8,132
June	6,062	5,593	6,733	March	-4,481	-2,599	-8,940
July	4,987	3,500	5,907	April	-4,295	-730	-6,943
August	2,624	1,061	4,015				
September	1,815	1,035	2,782				
October	1,117	-1,554	2,177				
November	254	-999	1,431				

[a]Comparison of present river flows that would have occurred without Oroville Dam.

Table 4-4. Monthly Summary of Sacramento River Flows during 2002 (cfs)

	At Freeport			At Rio Vista		
	Mean	*Low Daily*	*High Daily*	*Mean*	*Low Daily*	*High Daily*
Jan	38,355	19,360	65,552	38,271	16,664	92,087
Feb	18,238	14,396	31,120	15,174	11,875	26,170
Mar	21,351	17,443	28,868	18,083	14,229	24,442
Apr	14,487	10,936	16,998	11,763	8,663	13,999
May	12,922	9,582	20,263	10,366	7,370	17,464
Jun	13,809	11,102	17,501	8,064	5,957	9,600
Jul	18,821	16,516	20,629	10,069	8,478	11,399
Aug	16,960	13,508	18,878	9,050	7,288	10,365
Sep	13,554	12,245	14,464	6,916	5,926	7,526
Oct	9,930	9,204	12,066	5,749	4,015	7,825
Nov	11,827	9,879	15,384	9,703	7,431	15,849
Dec	29,189	10,050	57,452	23,689	5,480	50,979

Note: Flows between Freeport and Rio Vista are diminished by diversions into the Delta Cross Channel or into Georgiana Slough.

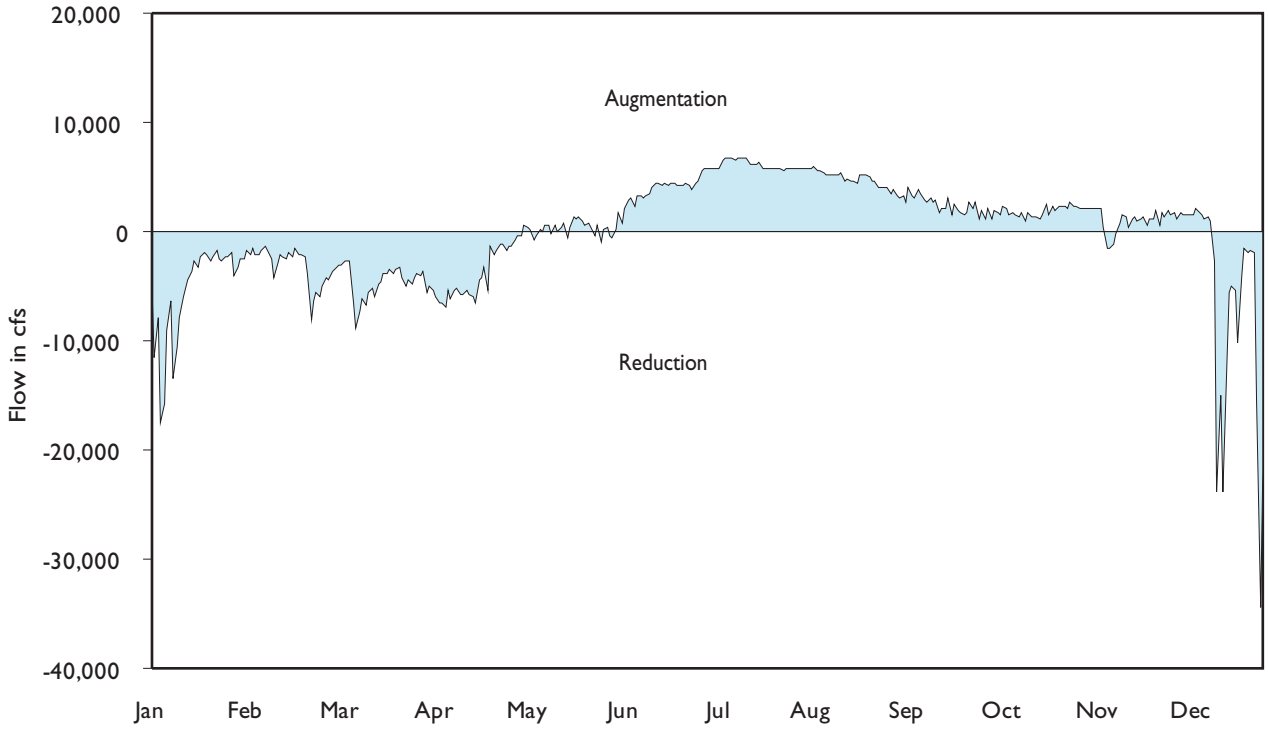


Figure 4-3. Effect of SWP operations on Feather River flow during 2002

Table 4-5. Institutional Framework for SWP Operations in the Sacramento-San Joaquin Delta during 2002

- Agreement between DWR and DFG concerning operations of the Oroville Division of the SWP for the management of fish and wildlife - 7/67 and 8/83
- U.S. Army Corps of Engineer's Section10 permit and Public Notice 5820-A 10/81. Permitted operations of Banks Pumping Plant.
- Agreement between the United States and State of California for Coordinated Operation of CVP and the SWP (COA) - 1986
- Agreement between DWR and DFG to offset direct fish losses in relation to the Banks Pumping Plant (Four Pumps Agreement) - 12/86
- Suisun Marsh Preservation Agreement signed by the Department, the Bureau, DFG, and SRCD - 3/87
- Central Valley Project Improvement Act (PL 102-575, Title 34) (CVPIA) - 9/92
- NMFS Biological Opinion for Winter-run Salmon, long-term, 2/93. Amended 5/95 to conform to Bay/Delta Accord
- USFWS Formal Consultation on the 1994 Operation of the CVP and SWP: Effects on Delta Smelt (Long-term Biological Opinion) - 1/94, amended 3/95 to conform to the Bay/Delta Accord
- Framework Agreement between the Governor's Water Policy Council of the State of California and the Federal Ecosystem Directorate - 6/94
- Monterey Agreement - Statement of Principles by the State Water Contractors and the State of California Department of Water Resources for potential amendments to the State Water Supply contracts - 12/94
- Principles For Agreement On Bay-Delta Standards Between The State Of California and The Federal Government (Bay-Delta Accord) - 12/94
- Formal Consultation and Conference on Effects of Long-Term Operation of the Central Valley Project and State Water Project on the Threatened Delta Smelt, Delta Smelt Critical Habitat, and Proposed Threatened Sacramento Splittail, USFWS - 3/95
- Water Quality Control Plan for the San Francisco Bay /Sacramento-San Joaquin Estuary (1995 Bay-Delta Plan) 5/95
- SWRCB Water Right Decision 1641 - Conditions the water rights permits of the SWP and CVP to implement the water quality objectives of the 1995 Bay-Delta Water Quality Control Plan - 12/99
- Water Right Order 2000-02 - Order denying petitions for reconsideration and amending SWRCB Decision 1641 - 3/00
- Water Right Order 2001-05 - Order staying and dismissing Phase 8 of the Bay-Delta Water Right Hearing and amending revised Decision 1641 - 4/01
- Water Right Order 2002-03, Order denying reconsideration of D-1641 and approving a water level response plan prepared by the Bureau and the Department, with input for the South Delta Water Agency, to ensure water levels would not be harmed by changes inpoints of diversion in the south Delta - 5/28/02
- Water Right Order 2002-12, Order postponing the automatic dismissal of Phase 8 from 12/15/02 to 1/31/03, to allow additional time for negotiations and the completion of a short-term settlement agreement designed to help implement measures in the 1995 Bay-Delta Plan.

required by D-1641 to mitigate the effects of changed points of water diversion upon the southern Delta by ensuring that water levels in the southern Delta would not be lowered to the harm of water users in the south Delta.

Water Right Order 2002-12 postponed the automatic dismissal of Phase 8 of the Bay-Delta Water Rights Hearing. SWRCB issued the order following requests from the Department and the Bureau for a postponement of the dismissal from December 15, 2002 until January 31, 2003. The postponement was needed to allow additional time for the completion of negotiations and to execute a short-term settlement agreement designed to carry out measures that would help implement the objectives in the 1995 Bay-Delta Plan.

With the exception of these newly adopted criteria, the operational criteria will not be described further in this report. For additional information on these criteria, please refer to Bulletin 132-98 Appendix E.

During 2002, the Department and the Bureau operated joint projects in accordance with SWRCB's D-1641, which includes water quality, flow, and operational criteria for the estuary. Operations of the SWP and CVP were coordinated with various objectives of CALFED, the 1995 Bay-Delta Plan, Central Valley Project Improvement Act, and biological opinions for fish species listed under federal and State endangered species acts. As mentioned in the Summary, the CALFED ROD mandates an Environmental Water Account managed by the Department, the Bureau, DFG, and USFWS for the protection of listed fish species. Fish species currently listed under the federal and State ESA include the winter and spring runs of Chinook salmon, Delta smelt, steelhead, and splittail. Real-time monitoring of fish movement and conditions in the estuary aid daily water management by providing more timely information for the protection of targeted fish species from entrainment at the Delta pumping facilities of the SWP and CVP, ensuring water supply reliability.

The CALFED Bay-Delta Program

The CALFED Bay-Delta Program began in 1995 to address environmental and water management problems associated with the Bay-Delta. It is a cooperative effort among State and federal

Decker Island Project habitat mitigation where tidal habitat is being recreated.

agencies, urban and agricultural water users, fishing interests, environmental organizations, business interests, and others with a common goal of finding solutions to the problems facing the Bay-Delta. The Department has been an enthusiastic proponent of CALFED, recognizing it as a means of developing the State's water resources to the benefit of both the public and the environment, as well as fulfilling the water obligations of the SWP.

CALFED released the Draft Programmatic Environmental Impact Statement/Environmental Impact Report for the Bay-Delta Program on June 25, 1999, followed by a 90-day public comment period. On July 21, 2000, CALFED released the final EIS/EIR.

In June 2000, a plan was published to resolve Delta water issues and address its future water challenges *(California's Water Future: A Plan for Action*). This plan was formalized in the CALFED Record of Decision issued on August 9, 2000. The Department has taken a prominent role in the implementation of the CALFED plan, participating in programs relating to water storage, Delta water conveyance, Delta levees, watershed management, water use efficiency, and water quality.

During 2002, the Governor signed the California Bay-Delta Authority Act of 2003. This act, which will become effective January 1, 2003, provides a permanent governance structure for the collaborative State-federal effort which began in 1994. The new agency, California Bay-Delta Authority will be housed within the Resources Agency and is charged with ensuring balanced implementation of the CALFED Bay-Delta Program. In addition, a new Bay-Delta Public Advisory Committee was created. During 2002, the lack of State and federal funding impeded progress on the CALFED water management and finance plan, in addition to tribal coordination and environmental justice activities.

Delta Cross Channel Gate Operations

Sacramento River flow at Walnut Grove in the northern Delta (between Freeport and Rio Vista) can be diminished by water diversion into the Delta Cross Channel (gated diversion canal constructed and operated by the Bureau) or into Georgiana Slough, a natural channel just downstream of the Delta Cross Channel.

DCC gates are operated in response to a variety of criteria relating to flow, water quality, and fisheries. D-1641 calls for closure of the gates from February 1 until May 20; they may be closed for a total of 14 days during May 21 through June 15. From November through January, the gates may also be closed for a total of 45 days for fisheries protection, as requested by USFWS, NMFS, and DFG. During all these periods, the CALFED Operations Group determines timing and duration of gate closures.

In 2002, the DCC gates were open for 194 days (Figure 4-4). They remained closed from January 1 through late May. On May 29, the gates were opened for Memorial Day weekend to allow passage of recreational boats. Following a brief closure, the gates were opened again on May 31 to conduct an experiment for a 2-week period in which the gates were opened and closed on a 15-hour interval to determine impacts to fisheries and water quality. The gates were opened on June 14, following the gate experiment, and remained open until mid-October.

On the morning of October 16, the gates were closed to conduct a 3-day fish study. The gates were reopened on October 19, but as the study ended, gate #2 malfunctioned and fell. It remained closed until November 12 when both gates were closed to conduct maintenance and repairs. The repairs were completed later that same day and both gates were reopened. The gates were closed again on December 3 for a 7-day period because fish sampling found young out-migrating Chinook salmon in the north Delta. High Sacramento River flows caused the gates to be closed on December 16, 2001 and they remained closed through the balance of the year.

Flow Standards

D-1641 sets flow rate objectives for the San Joaquin River at Vernalis, the Sacramento River

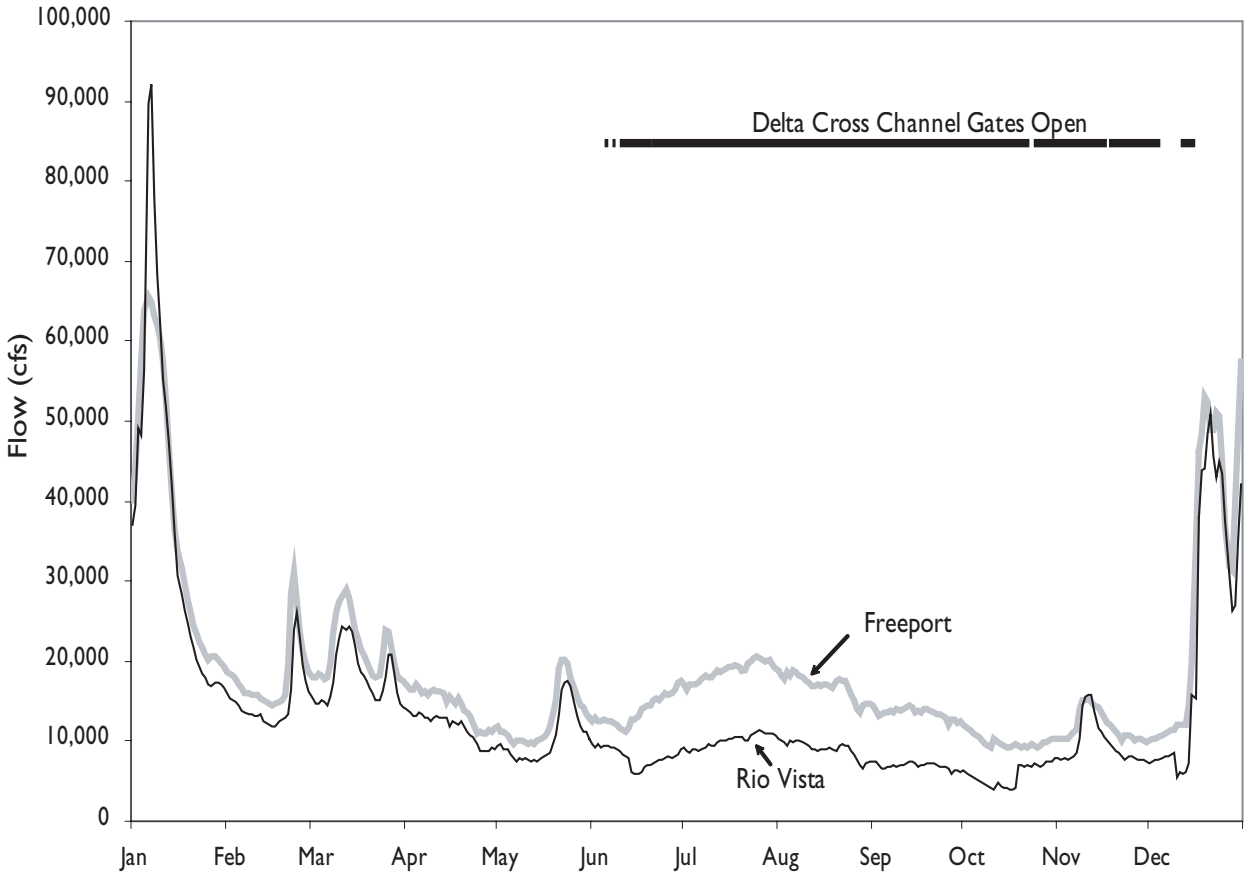


Figure 4-4. Sacramento River flows and Delta Cross Channel status during 2002

at Rio Vista, and the Delta using the Net Delta Outflow Index. Real-time fisheries monitoring is a tool used to determine the timing and duration of the San Joaquin River at Vernalis flow standard during April, May, and October. The 2002 Real-time Monitoring Program sampled fish 5 days per week at as many as 60 San Francisco Bay and Delta sites from March 18 through June 29. The RTM Data Summary Team provided a synopsis of the monitoring results, and recommendations to the CALFED Operations Group for making water project operational decisions. During 2002, all flow objectives were met with the exceptions of the Vernalis flow objective February, March and the first half of April. The Bureau is responsible for meeting the Vernalis flow objective as a requirement of its New Melones Reservoir water right permit. The Bureau notified SWRCB that water monies were not available to meet the objective. SWRCB decided that since the lower flows did not result in harm to Delta smelt, the Bureau should dedicate a similar quantity of water to fishery purposes later in the year. The make-up water was not required to come from New Melones Reservoir.

Vernalis Flow. Vernalis is located at the southernmost boundary of the Delta near the confluence of the Stanislaus and San Joaquin Rivers. The *Vernalis flow* represents the San Joaquin River's contribution to Delta inflow.

The Vernalis minimum monthly flow objective changes with water year type and is also dependent on whether the Habitat Protection Standard (X2) is met to the east or west of Chipps Island. The San Joaquin Valley 60-20-20 Index at the 75 percent exceedence level determines the Vernalis water year type. During 2002, X2 was located at Chipps Island from February through May; as a result, Vernalis flows were required to

meet the higher base flow objective of 2,280 cfs for those months. During June, X2 was located east of Chipps Island relaxing the base flow objective to 1,420 cfs. The Vernalis flow objective was not met during the months of February, March, and the first half of April. As stated previously, the Bureau informed SWRCB that water monies were not available to meet the objective.

During water years classified as *dry* or *below-normal*, a base flow minimum is set at 1,420 cfs (monthly or partial monthly average) for the-Joaquin River at Vernalis from February 1 through April 14 and May 16 through June 30 when X2 is met east of Chipps Island. The Vernalis flow objective increases to 2,280 cfs during months when X2 is located at or west of Chipps Island.

This Vernalis base flow objective helps to maintain a positive outflow through the central

A Great Egret enjoying the day in the Sacramento-San Joaquin Delta

Delta, which reduces reverse flow conditions and fish entrainment at the export pumps. The 7-day average must not be less than 20 percent of period mean. During 2002, the Vernalis monthly flow averaged 1,895 cfs, 2,131 cfs, and 1,822 cfs for February, March, and the first half of April, respectively. Flows averaged 2,316 cfs during the latter half of May and were 1,429 cfs during June. (Table 4-6, Figure 4-5).

D-1641 includes a spring pulse flow objective for the San Joaquin River at Vernalis, which is also conditioned by the San Joaquin Valley 60-20-20 Index and the X2 compliance location. This spring pulse flow aids in the transport of Delta smelt out of the southern and central Delta into Suisun Bay during their critical spawning period. The pulse flow's timing and duration is based on real-time fisheries monitoring to coincide with fish migration in the San Joaquin River and its tributaries. The spring pulse flow period contained within D-1641 coincides with the Vernalis Adaptive Management Program's spring experimental period. VAMP export and flow criteria are recognized by SWRCB as an alternative to spring pulse flow criteria contained within D-1641. The Department and the Bureau are participants in the San Joaquin River Agreement, which facilitates VAMP. The SWP and CVP typically opt to use the spring pulse flow and export targets included in VAMP. This resulted in a flow target of 3,200 cfs—actual flows averaged 3,300 cfs during the April 15 to May 15 pulse flow period.

A pulse flow minimum of 1,000 cfs applies during October, with the addition of 28,000 af pulse/attraction flow to bring San Joaquin River flows up to as much as 2,000 cfs. The CALFED Operations Group may also determine timingand duration of these flows based on real-time fisheries monitoring.

Rio Vista Flow. Sacramento River flow at Rio Vista can be reduced by upstream diversions via the Delta Cross Channel, natural channels, and by Delta consumptive use, in addition to being opposed by tidal flow. D-1485 previously required year-round flow minimums at Rio Vista, but the 1999 adoption of D-1641 replaced

Table 4-6. San Joaquin River Flow Objectives Measured at Vernalis during 2002 (cfs)

Period	Objectives and Flows	
	Monthly or Period Mean	*Actual Monthly or Period Mean*
Base Flow[a]		
Feb	1,420 or 2,280	1,895
Mar	1,420 or 2,280	2,131
Apr 1-14	1,420 or 2,280	1,822
May 16-31	1,420 or 2,280	2,316
Jun	1,420 or 2,280	1,429
Oct[b]	2,000	1,562
Pulse Flow		
Apr 15 - May 15	3,200[c]	3,300
Combined exports limited by the Vernalis Adaptive Management Program[c] The Department is a participant in the San Joaquin River Agreement which facilitates VAMP.		
	Export Limit	*Combined Exports*
Apr 20 - May 20	1,500	1,464

Additional base flow criteria:

[a]7-day running average shall not be less than 20% below the flow rate objective.

[b]1,000 cfs plus an additional 28,000 af pulse/attraction flows to bring monthly average up to 2,000 cfs; timing is determined by CALFED Operations Group.

[c]SWRCB allows use of alternative San Joaquin flow and south Delta export targets contained within the Vernalis Adaptive Management Program.

D-1485, thus eliminating the year-round flow minimums. D-1641 does set Rio Vista mean-monthly flow minimums of 3,000 cfs, 4,000 cfs and 4,500 cfs, for September, October, and November-December, respectively, for all water year classifications except critical years. During these compliance periods, the 7-day running average daily mean cannot be more than 1,000 cfs below the required monthly average. During 2002, the Rio Vista mean monthly flow fell to its lowest level in October, averaging 5,749 cfs. All Rio Vista flow standards were met during 2002 (Table 4-7, Figure 4-6).

Net Delta Outflow Index. Actual measurements of net Delta outflow are impractical because of tidal influence. However, since net outflow is one of the primary factors controlling Delta water quality, the Net Delta Outflow Index was developed as part of the Bay/Delta Accord. NDOI is derived using flows from the Sacramento River, the San Joaquin River at Vernalis, the Yolo Bypass, the Eastside stream system (the Mokelumne, Cosumnes, and Calaveras Rivers), some miscellaneous creeks, sloughs, and canals, and discharges from the Sacramento Regional Wastewater Treatment Plant. Major Delta exports and an estimated in-Delta water use factor is then deducted from the cumulative inflow total to produce the index.

D-1641 contains minimum monthly average NDOI standards for January and July-December. During January, the minimum monthly flow for all water year types is set at 6,000 cfs when the previous month's Eight River Index (PMI) is greater than 800 taf; otherwise it drops to 4,500 cfs. The dry-year minimum monthly NDOI objectives for July, August, September, and October are 5,000 cfs, 3,500 cfs, 3,000 cfs,and 4,000 cfs, respectively, and they rise to 4,500 cfs for November and December.

D-1641 also sets a habitat protection outflow from February through June, with a minimum

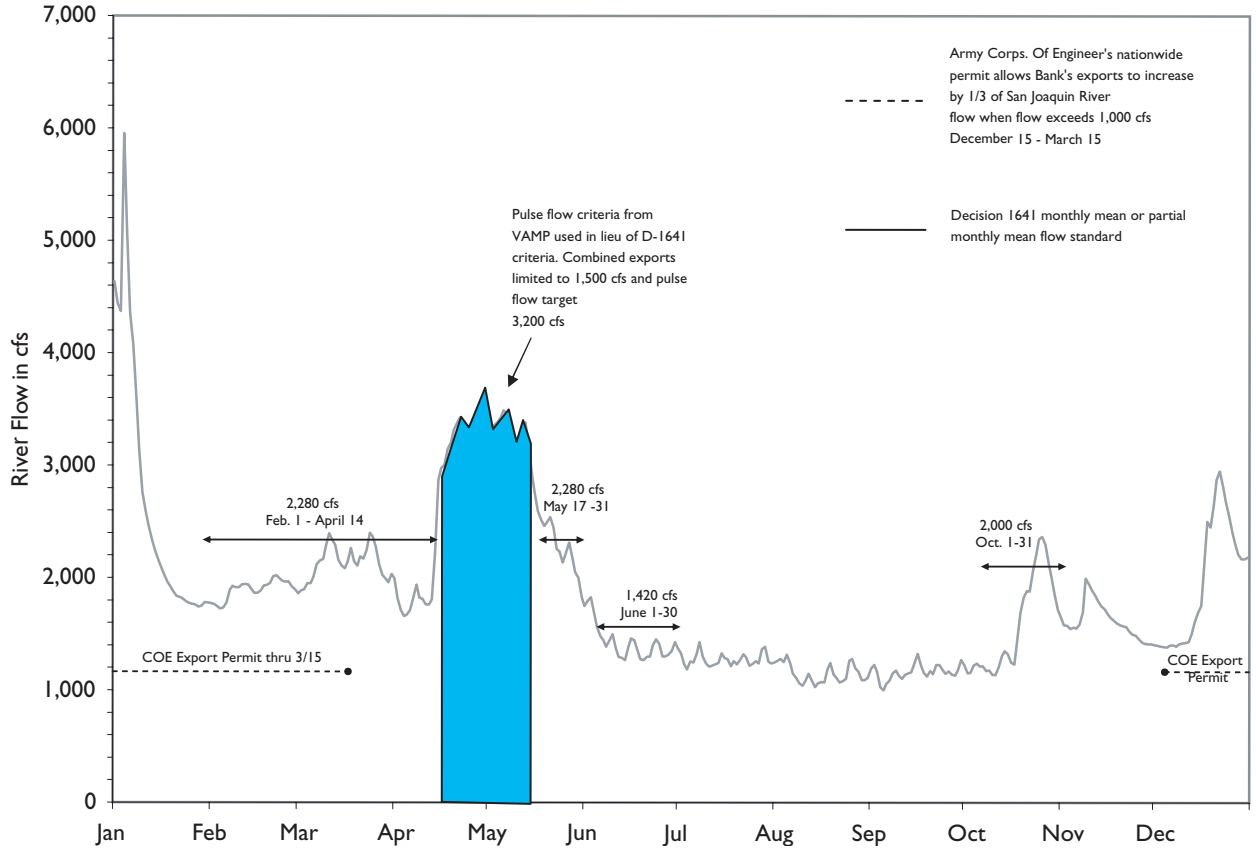


Figure 4-5. San Joaquin River flow standard and operational criteria at Vernalis in 2002

Table 4-7. Sacramento River Standards at Rio Vista for Dry Year 2002 (cfs)

	D-1641 Standards	Actual Flows	
Month	*Monthly average*	*Lowest 7-day average flow*[a]	*Monthly average flow*
Sep	3,000	6,180	6,472
Oct	4,000	3,839	4,242
Nov	4,500	3,956	8,006
Dec	4,500	15,302	23,847

[a]7-day running average shall not be less than 1,000 cfs below monthly standard.

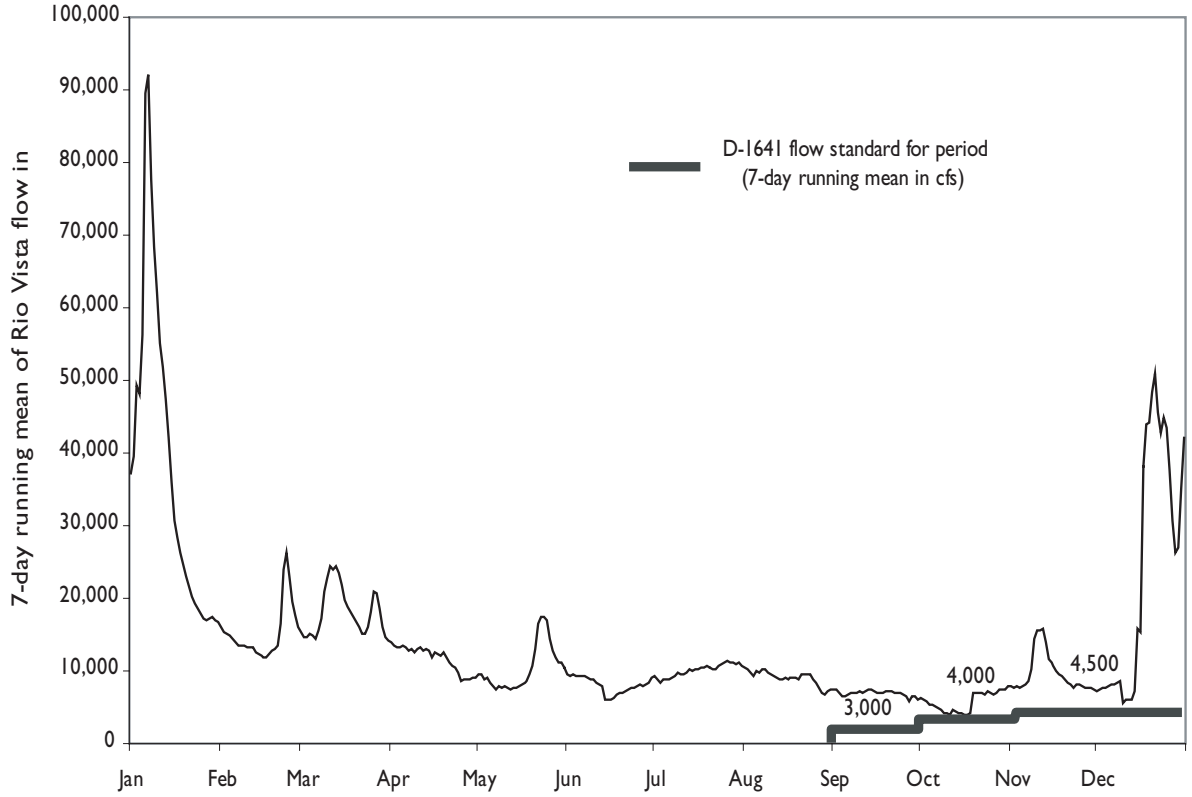


Figure 4-6. Sacramento River dry-year flow minimums at Rio Vista in 2002

daily NDOI of 7,100 cfs calculated as a 3-day running average. The objective may also be met by a daily average or 14-day running average EC of 2.64 mS/cm at Collinsville. Monthly NDOI habitat protection minimums for February through June are 7,100, 11,400, or 29,200 cfs depending upon whether X2 compliance is met at Collinsville, Chipps Island, or Port Chicago, respectively.

All NDOI standards were met during 2002. The highest monthly average NDOI occurred in January with 37,812 cfs and the lowest occurred in August with 3,586 cfs (Table 4-8, Figure 4-7).

Delta Exports

The Sacramento-San Joaquin Delta provides the major source of water for SWP deliveries south of the Delta. Inflow from the Kern River Intertie and storm flows entering the California Aqueduct are also water sources for the SWP although there were no inflows from the Intertie or floodwater flows in 2002, as mentioned in Chapter 3.

Banks Pumping Plant has the capacity to export water at a rate of 10,670 cfs, although the Aqueduct capacity below Banks Pumping Plant physically limits exports to 10,300 cfs. In addition, a Corps permit (Public Notice 5820A) limits the diversion rate at Clifton Court Forebay to 6,680 cfs, except from December 15 to March 15, when exports may increase by one-third of the San Joaquin River flow when its flow exceeds 1,000 cfs. San Joaquin River flow at Vernalis was in excess of 1,000 cfs throughout 2002, allowing corresponding increases in the export rate. Export pumping rates are increased on weekends to take advantage of less expensive off-peak electrical energy. This produces sharp peaks in the export rate at about 7-day intervals (Figure 4-8).

Table 4-8. D-1641 NDOI Flow Standards during 2002 (cfs)

Flow Standards	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NDOI												
MM>	4,500[a]						5,000	3,500	3,000	4,000	4,500	4,500
Min. daily 3-dm		7,100	7,100[b]	7,100	7,100[c]	7,100[c]						
Min. daily 14-dm												
Actual Flows												
MM	37,812	18,592	12,240	17,110	13,618	6,803	5,189	3,586	3,926	4,097	7,471	25,445
Min 3-dm flow		8,606	11,463	9,540	10,591	4,856						

Note: Shaded areas = standard; MM = mean monthly; 3-dm = 3-day mean; 14-dm =14-day mean

[a]If PMI >800 taf, January standard rises to 6,000 cfs.

bMarch standard may be relaxed if PMI is <500 taf.

[c]If May estimate of Sacramento River Index is less than 8.1 maf, May and June MM objective set at 4,000 cfs

[d]The NDOI standard was met during June with both flows over 7,100 cfs and EC at Collinsville below 2.64 mS/cm.

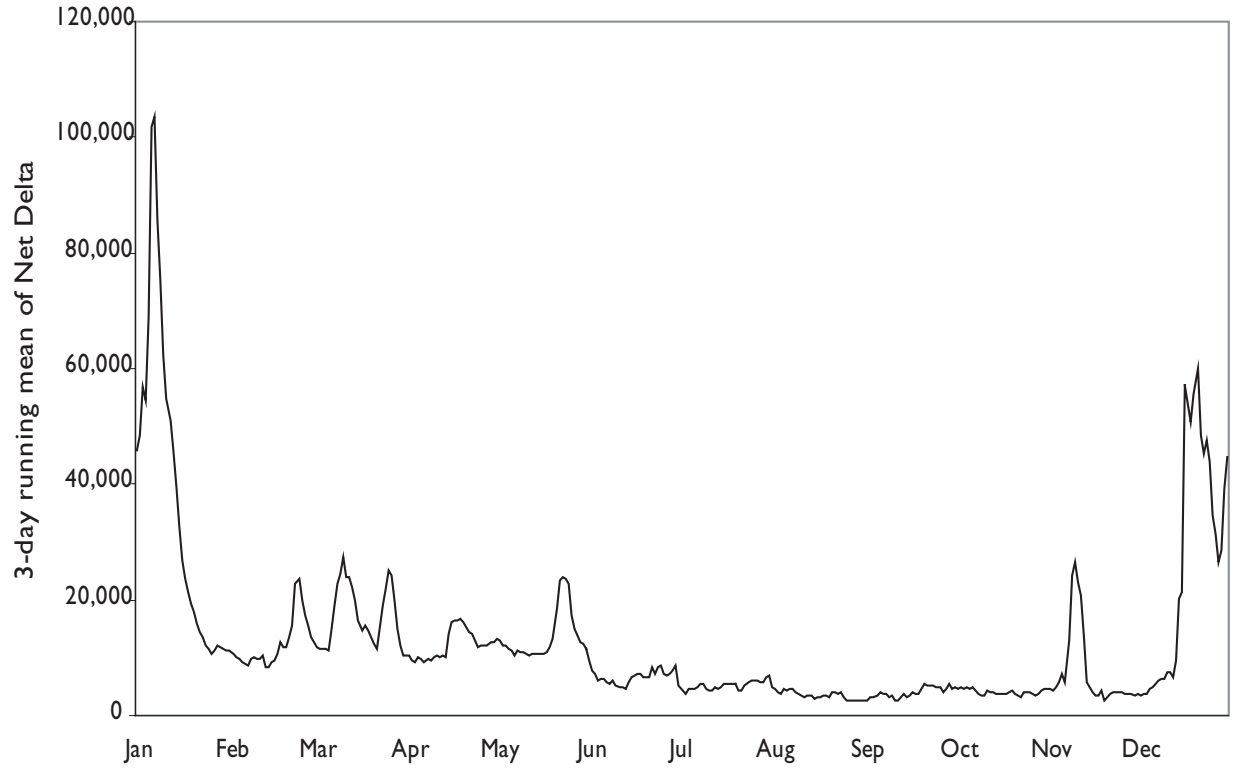


Figure 4-7. Net Delta Outflow Index in 2002

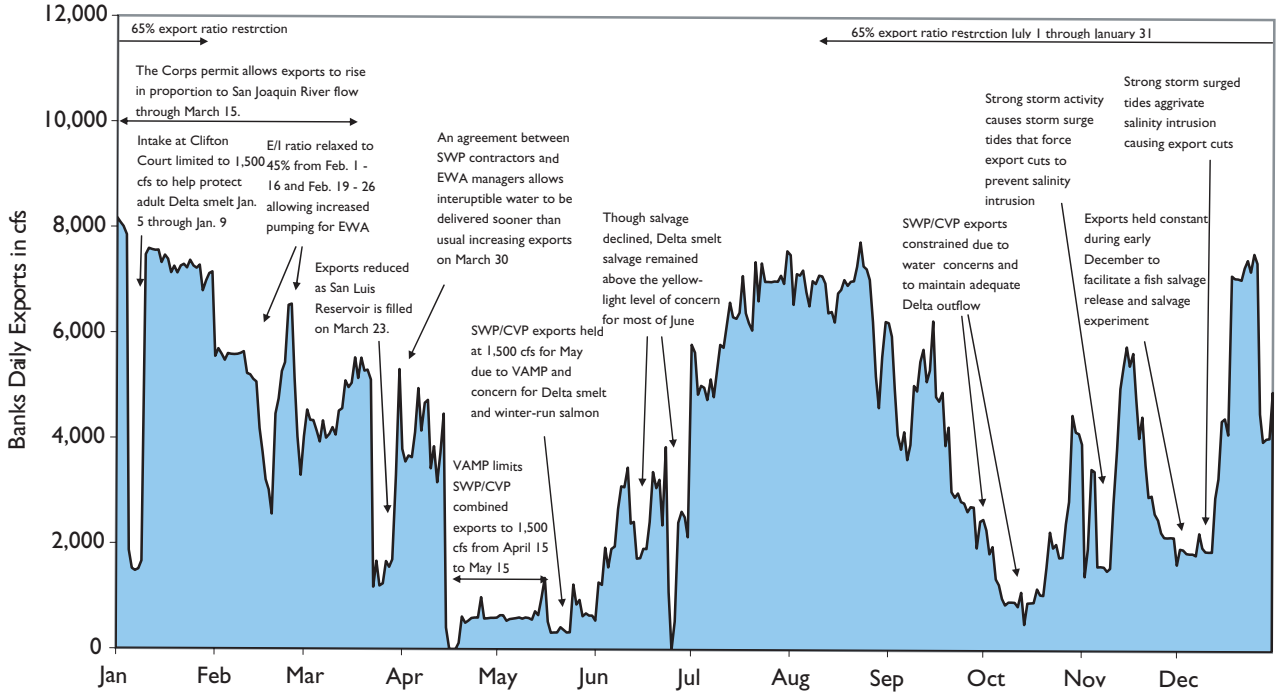


Figure 4-8. SWP Banks Pumping Plant exports during 2002, annotated with significant factors affecting export

In 2002, the SWP pumped 2.79 maf of water at Banks Pumping Plant, which is about 121 percent of 2001 exports (2.31 maf), and 69 percent of all SWP deliveries, both SWP contractual and noncontractual (4.06 maf). Under the 1986 COA, SWP may export water for CVP later in the year to make up for exports not taken at its Tracy Pumping Plant under fisheries-related restrictions. D-1641 allows the SWP and CVP to use either project's pumping plants for exports to make up for export losses incurred for the protection of fisheries. These export exchanges may not jeopardize either project's deliveries and require permission from the CALFED Operations Group. Banks Pumping Plant pumped 138,575 af of water for the CVP during 2002 (Table 4-9).

Winter-run Chinook Salmon Export Restrictions. The long-term Winter-run Chinook Salmon Biological Opinion, released in 1993 and amended in March 1995, can restrict Delta exports based on the combined loss of winter-run-sized salmon smolts at the State and federal Delta export facilities, known as the *take level*. The Biological Opinion's incidental take statement invoked what is known as a *yellow-light warning condition* when combined loss (Banks and Tracy) reached 19,911 smolts, equivalent to 1 percent of the 2001 estimated outmigrating juvenile winter-run salmon population. The Department and the Bureau voluntarily adjust pumping operations to reduce loss numbers when yellow-light conditions are reached. Loss levels at 2 percent, or 39,823 smolts, trigger what is known as a *red-light warning condition* and consultation with the Winter-run Chinook Salmon Monitoring Group is initiated. These yellow and red-light export restrictions were in effect from October 2001 through May 2002, the predominant period of salmon migration. The fish loss or estimated take is actually a calculated value derived from combined salvage numbers at SWP and CVP fish facilities expanded by empirically determined factors including sampling duration, salvage efficiency, forebay predation, and losses due to handling and hauling.

The combined SWP/CVP seasonal winter-run–sized salmon loss for 2002 was 3,288 smolts. The loss did not affect exports since it never reached the yellow-light level of concern. (Figure 4-9).

Delta Smelt Export Restrictions. The amended Delta Smelt Biological Opinion established a year-round Delta smelt salvage action level of 400 fish (14-day running mean of daily salvage), known as the *yellow-light level,* which triggers informal consultation with USFWS, the Bureau, DFG, and the Department. The combined salvage is the sum of Delta smelt salvaged at Banks and Tracy Pumping Plants expanded by other factors similar to those used in the winter-run salmon calculation. The *red-light level* is the cumulative total of the combined salvage for each month and varies by water year type, with below-normal water years generally having a higher red-light level than the level set for above-normal water years. Red-light levels for above-normal water years are 2,378 for April and 9,769 for May and increase to 12,345 for April and 55,277 for May during below-normal water years. Reaching the red-light level triggers formal consultation with the fisheries agencies to determine whether additional actions are necessary to avoid jeopardizing the species.

Concern over Delta smelt salvage during early January 2002, resulted in curtailment of diversions into Clifton Court Forebay to 1,500 cfs from January 5 through January 9. The yellow-light level was not exceeded during January and water was earmarked from the EWA to insure that there was no loss of SWP water as a result of the curtailments.

During the VAMP period, which extended from April 15 to May 15, combined exports averaged approximately 1,500 cfs. Following the VAMP period, exports remained relatively low for the protection of Delta smelt. On May 16 and 25 the Department's Operations Control Office conducted a salvage sensitivity experiment at Clifton Court Forebay. Banks Pumping Plant was run at high levels to test the impact on Delta smelt salvage. While no definitive conclusions were reached following the tests, some agency biologists agreed that high Delta smelt salvage following the VAMP period results from Delta smelt rearing in the Forebay and is likely not an indication of distribution in the south Delta. Due in part to the salvage experiment, the salvage of adult Delta smelt peaked during May 2002 at almost 47,400. Despite the high levels of salvage in May, the Delta smelt red-light level was never exceeded in 2002 (Figure 4-10).

Table 4-9. Delta Exports at Tracy and Banks Pumping Plants during 2002

Month	Export Rate SWP (cfs)	Banks Export For SWP (af)	Banks Export For CVP (af)	Total Banks Exports (af)	Total Tracy Exports (af)	SWP/CVP Combined Exports (af)
Jan	200,514	397,017	0	397,017	254,397	651,414
Feb	138,628	274,484	0	274,484	199,824	474,308
Mar	120,861	239,304	0	239,304	256,707	496,011
Apr	63,241	125,217	0	125,217	127,398	252,615
May	19,422	38,455	0	38,455	52,580	91,035
Jun	64,505	127,719	0	127,719	150,595	278,314
Jul	159,490	315,791	43,824	359,615	267,309	626,924
Aug	188,130	372,498	21,699	394,197	266,195	660,392
Sep	92,731	183,607	57,509	241,116	254,147	495,263
Oct	41,071	81,320	20,519	101,839	250,896	352,735
Nov	88,267	174,768	12,303	187,071	218,052	405,123
Dec	128,455	254,341	0	254,341	204,604	458,945
Total	----------	**2,584,521**	**155,854**	**2,740,375**	**2,502,704**	**5,243,079**

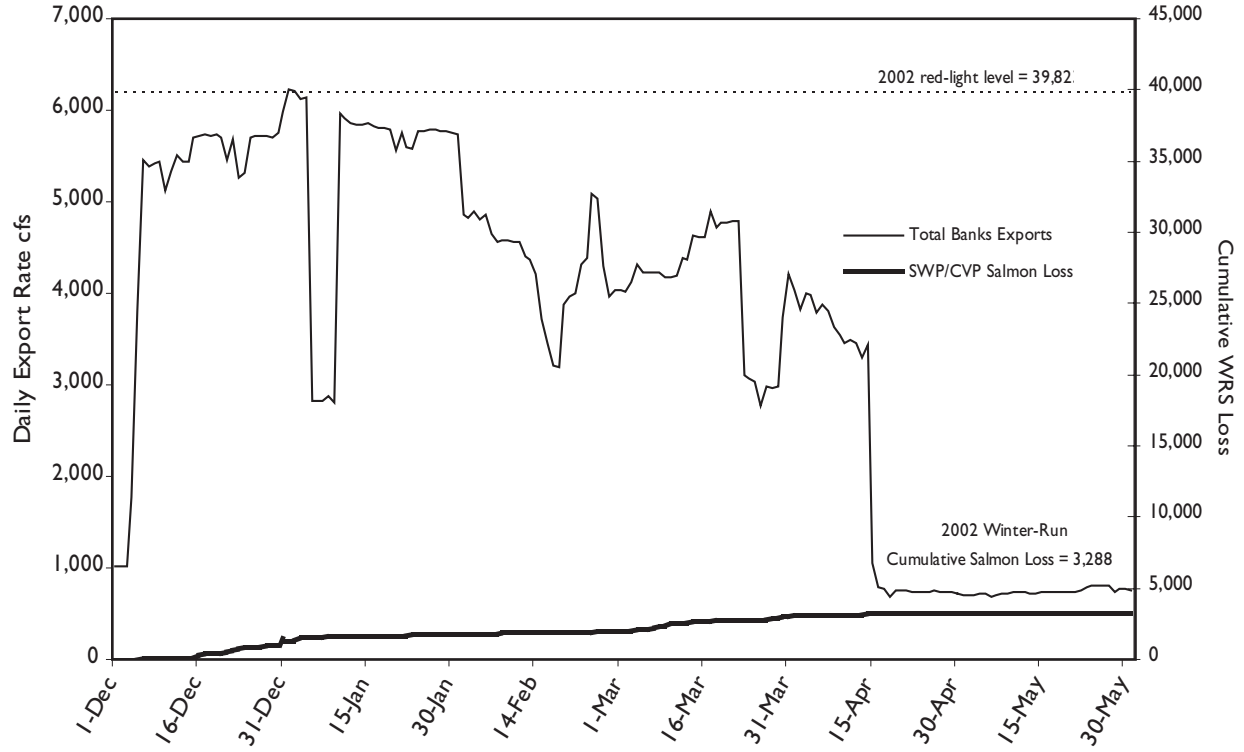


Figure 4-9. SWP/CVP cumulative winter-run salmon loss estimate and Banks Pumping Plant exports from December 1, 2001 to May 31, 2002

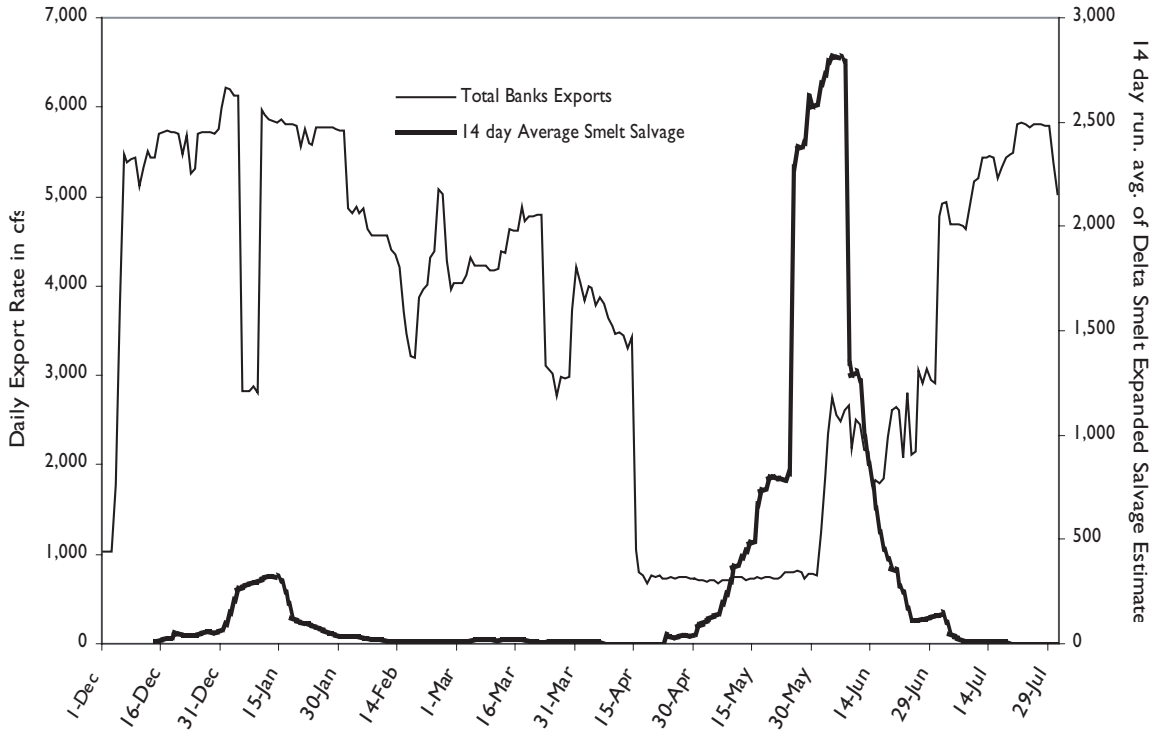


Figure 4-10. Expanded Delta smelt salvage estimates and Banks Pumping Plant exports in 2002

Sacramento Splittail Salvage. USFWS listed the Sacramento splittail as threatened under the federal Endangered Species Act on February 8, 1999. The listing, which became effective on March 10, had been considered since 1994. During 2000, a Federal District Court Judge found that the decision by USFWS to list the splittail as endangered under FESA was not reached in accordance with the law. The judge remanded the decision to USFWS for further analysis and review. The Department and the Bureau have continued to meet with USFWS in an effort to establish an incidental take statement for operation of the SWP and CVP. A final ruling is still pending and is expected in early 2003. Though no formal take limits for splittail were in place during 2002, the fish salvage facilities of the SWP and CVP kept an accurate count of the combined splittail salvage. The combined salvage during 2002 is illustrated in Figure 4-11.

Skinner Fish Facility salvages fish from export operations at Banks Pumping Plant

D-1641 Export Restrictions

D-1641 contains a year-round export standard, known as the *percent inflow diverted ratio,* that restricts exports by limiting them in proportion to Delta inflow. The percent inflow diverted standard is the sum of SWP and CVP south Delta exports divided by Delta inflow. The percent inflow diverted standard is calculated using a 3-day running average of exports and a 14-day running average of Delta inflow. During periods when CVP or SWP exports are dependent upon storage withdrawals from upstream reservoirs, the percent inflow diverted ratio is computed using 3-day running averages of both export rate and Delta inflow.

This percent inflow diverted ratio objective varies by month and is conditioned by the previous month's Eight River Index. The combined CVP/SWP export standard is typically set at 35 percent of Delta inflow from February through June and 65 percent during January and the remainder of the year. The February standard can incrementally be increased to 45 percent when January's Eight River Index is less than 1.5 maf. In addition, the CALFED Operations Group can relax the standard to pump water for the EWA, make up exports lost during fisheries-related restrictions, as well as other operational needs.

During January 2002, the percent inflow diverted average was only 43 percent even though the diversion of as much as 65 percent of Delta inflow is allowed for the month. SWP diversions into Clifton Court Forebay were limited to 1,500 cfs from January 5 through January 9 due to concern over the salvage of adult Delta smelt and the loss of winter-run Chinook salmon.

From February through June, the average percent of inflow diverted was 27 percent, well below the 35 percent standard. During February, exports averaged 42 percent of inflow for the month. The fisheries agencies agreed to allow the 35 percent of inflow diverted standard to

flex up to 45 percent between February 1 and 16 and between February 19 and 26 to pump water for the EWA. The relaxation of the percent diverted ended on February 26, 2002, due to concern over the salvage of salmon.

The percent inflow diverted standard controlled operations from March 1 through 22 as exports averaged just less than 35 percent during the entire 3-week period. San Luis Reservoir reached capacity on March 23, 2002, and this included 94,000 af water stored for EWA. The relaxation of the percent inflow diverted standard during February allowed water to be accumulated for EWA. This EWA water stored in San Luis Reservoir gave SWP and CVP operational flexibility and water available for fishery benefits later in the year.

During the first half of April, south Delta exports were governed in part by concerns for X2 compliance. The VAMP began operations on April 15 and combined exports were reduced to 1,500 cfs through May 15, 2002. During the 30-day VAMP period, exports averaged 9 percent of Delta inflow. Following the VAMP period, combined exports remained at about 1,500 cfs to provide additional protection for juvenile salmon and Delta smelt. On May 16 and 25, the Department's Operations Control Office conducted a salvage sensitivity experiment. The experiment was designed to test the theory that high Delta smelt salvage following the annual-VAMP period is the result of rearing in the Clifton Court Forebay and not an indication of Delta smelt distribution in the south Delta. The experiment involved running Banks Pumping Plant at high levels for several hours, while restricting inflow into Clifton Court Forebay, to weigh the impact on Delta smelt salvage. No definitive conclusions were reached.

Compliance with the NDOI standard of 7,100 cfs governed operations during most of

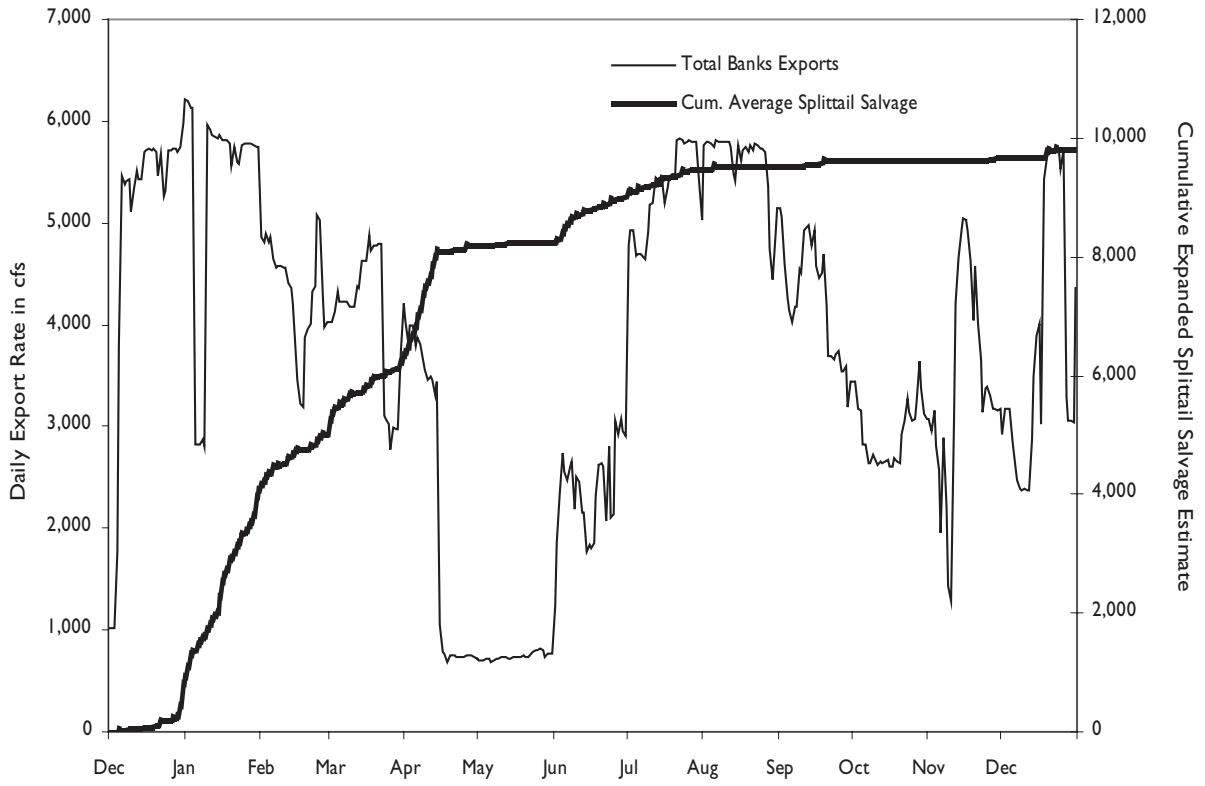


Figure 4-11. Expanded Sacramento splittail salvage estimates and Banks export pumping in 2002

June. Delta smelt salvage continued to be a concern through June 26, 2002. Aquatic weed treatment at Clifton Court Forebay on June 24 and June 26 resulted in a complete curtailment of exports at Banks Pumping Plant on June 25, 2002.

From July through December, when 65 percent of Delta inflow is allowed to be diverted by CVP and SWP, combined exports averaged only 49 percent during this period. NDOI requirements continued to control exports in the south Delta during July. There were also some concerns over low water levels at Tom Paine Slough in the south Delta. During August, maintaining compliance with the NDOI requirement of 3,500 cfs governed south Delta export operations and combined exports averaged 53 percent of Delta inflow for the month. The chloride standard at Contra Costa Canal Pumping Plant was at risk of being exceeded during September and October and south Delta water exports were hampered as a result. In fact, the 250 mg/L chloride standard at Contra Costa Canal Pumping Plant was exceeded eight times during October, 2002. The percent inflow diverted during September and October was 47 and 54 percent, respectively. In early November, strong storm activity caused very high tides and resulted in reduced exports in order to combat salinity intrusion. Following the storm, runoff and the neap tide quickly freshened water in the western and central Delta, alleviating most water quality concerns for the balance of November. Another strong storm event occurred in early December that also produced storm-surged tides. The storm surge coincided with a Delta fisheries experiment that required that the Delta Cross Channel gates be closed. This resulted in water quality concerns that required export reductions and the reopening of the Delta Cross Channel gates. As the storm passed, improving water quality conditions allowed unrestricted operations for the rest of the month. The percent of inflow diverted for November and December was 48 and 37 percent, respectively.

Spring Export Restrictions. D-1641 contains an export limitation applied during the spring pulse flow period on the San Joaquin River, limiting combined exports from April 15 through May 15 to 1,500 cfs, or 100 percent of the 3-day average of the San Joaquin River flow at Vernalis, whichever is greater. The San Joaquin River Agreement, completed in April 1998, includes VAMP, which contains SWRCB-approved alternate flow and export targets that may be used in lieu of the D-1641 criteria for the protection of San Joaquin River salmon. In 2002, the VAMP season extended from April 15 to May 15, during which SWP and CVP used 1,500 cfs as the combined export target. Actual exports were 1,464 cfs, which was about 9 percent of Delta inflow during this period.

All D-1641, ESA-related and VAMP export criteria were met during 2002 (Figure 4-12 and Table 4-10, also see Figure 4-11 and Table 4-9).

Environmental Water Account

EWA is a cooperative water management program made up of five State and federal agencies. EWA was mandated in the CALFED ROD. EWA is designed to help protect endangered and/or threatened fish species of the Bay-Delta estuary through environmentally beneficial changes in the operations of SWP and CVP, at no uncompensated water cost to the SWP/CVP water users.

Under EWA, fish protection is achieved when necessary by curtailing project water delivery from the Bay-Delta to project users south of the Delta and replacing it at a later date within the same calendar year. This necessitates the acquisition of alternative sources of project water called EWA *assets*, which are used to replace the project water supply (i.e., the undeliverable water). EWA assets consist of *variable assets*, which are acquired through changes in operations; *fixed assets*, which are acquired through purchases from willing sellers; and *source shifting*, which involves deferral of scheduled delivery of water allocations by willing participants.

EWA is considered operational for any year when these assets are in place and Endangered

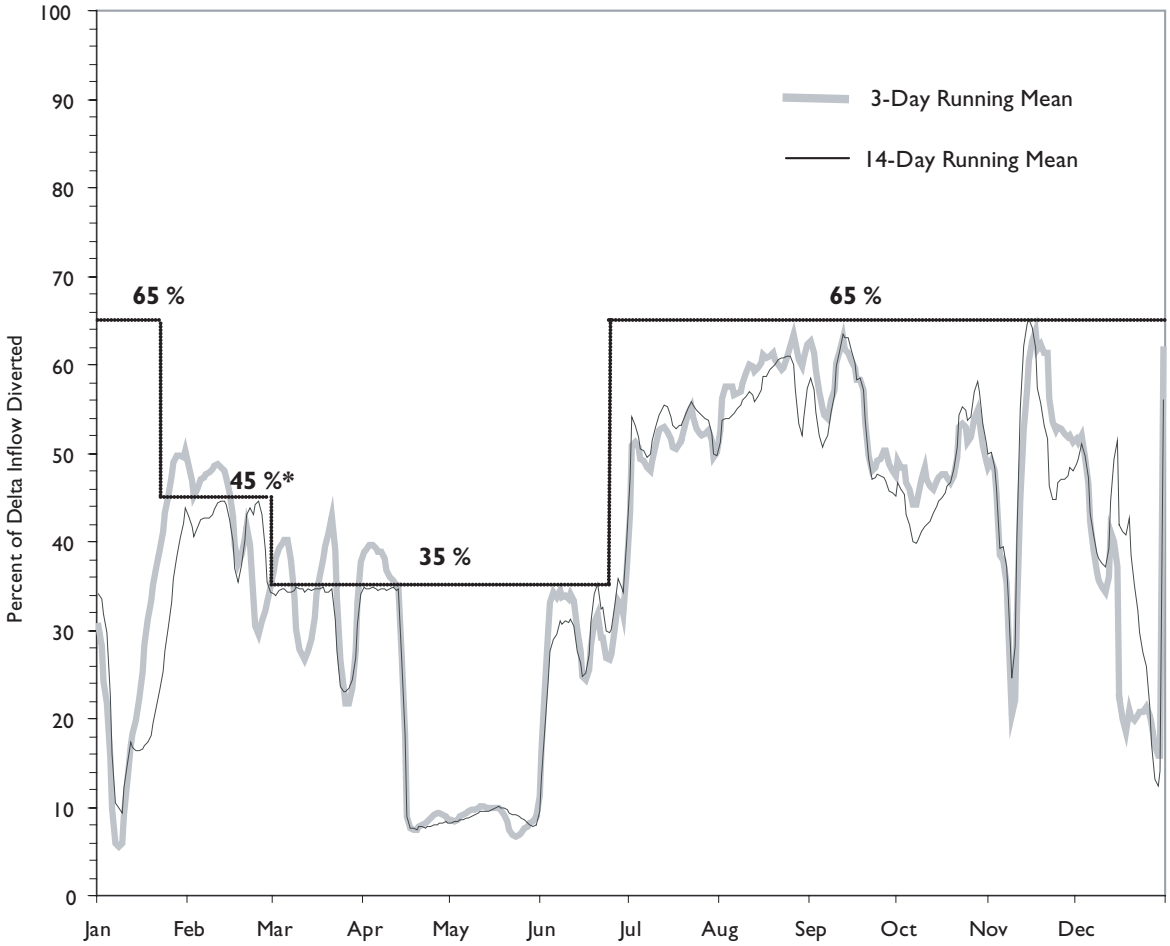


Figure 4-12. Combined Delta exports as percent of inflow diverted and D1641 Standards in 2002. Note that the export limit was raised to 45% during February to pump EWA water.

Species Act commitments are provided by the management agencies. The first fish actions occurred in January and continued throughout the year. Management agencies required 280,353 af of curtailments for fish protection, which was achieved by pumping reduction at the Banks and Tracy Pumping Plants in the south Delta. All fixed asset acquisitions in 2002 were made by the Department as single-year transactions; studies were carried out to ensure that the transactions complied with CEQA. This was the second year of EWA operation.

In 2002, to minimize spillage of EWA water from San Luis Reservoir, the Department implemented a *2 for 1 exchange* with the State Water Contractors. A total of 40,011 af of water was transferred to the contractors in return for 20,006 af of water transferred back by the contractors in July and August. Thus, a total of 20,006 af of water was saved for use later in the year. Later in 2002, 20,000 af of EWA water was stored at Lake Oroville to prevent subsequent spillage from San Luis Reservoir.

The Department was able to compensate the SWP and CVP for pumping reductions by acquiring 75,952 af of fixed assets through contract agreements. A source shift was not implemented because there was no risk of low water point problems at San Luis Reservoir. The initial year of EWA operation ended with an 87,710 af credit of water for use during 2002 EWA actions. The second year of EWA operation ended with 30,244 af credit of water for use during 2003 for EWA actions.

Table 4-10. D-1641 Export Limits Based on Percentage of Delta Inflow Diverted during 2002

Month	Maximum % Inflow allowed as combined export (%)	Mean % inflow diverted	
		3-day running mean[a]	*14-day running mean*[a]
Jan	65	29.1	23.9
Feb[b]	45	42.2	41.8
Mar		33.1	32.1
Apr[c]	35	23.1	21.3
May[c]		8.9	9.0
Jun		29.2	28.7
Jul		50.7	52.6
Aug		59.1	56.6
Sep	65	55.9	54.3
Oct		48.7	47.3
Nov		48.9	48.4
Dec		31.4	37.0

Note: Combined export is defined as Clifton Court Forebay inflow (minus BBID diversions from Clifton Court) plus Tracy Pumping Plant exports.

[a]Percent of Delta inflow diverted is calculated using the export rate as a 3-day running mean and the Delta inflow as a 14-day running mean, except when the SWP or CVP are making storage withdrawals for export. In this case, both the export rate and Delta inflow are 3-day running means.

[b]During February the E/I ratio limit was raised from 35 to 45 % for 24 days to pump water for the Environmental Water Account.

[c]VAMP provides alternative spring pulse flow and export criteria that is recognized by SWRCB and is used in lieu of D-1641 criteria.

North Bay Aqueduct Operations

The North Bay Aqueduct system begins in the north Delta at the Barker Slough Facilities near Rio Vista. Sacramento River and local watershed water passes through Cache, Lindsey, and Barker Sloughs to reach the Barker Slough Pumping Plant. From the Barker Slough Pumping Plant, water is conveyed by pipeline for 24 miles northwest to the Cordelia Pumping Plant. Deliveries are made to Solano County water users via turnouts along the pipeline and to Napa County users from the Cordelia Pumping Plant. NBA extends approximately 6 miles beyond the Cordelia Pumping Plant to the Napa Terminal Tank. This Aqueduct will ultimately supply 25 taf annually to Napa and 42 taf to Solano. During 2002, deliveries to NBA totaled 45,435 af, about 1 percent of total SWP deliveries.

The total deliveries to NBA included 30,528 af Table A water supply — 28,223 af (92 percent) to Solano and 2,305 af (8 percent) to Napa. Napa and Solano also received 3,069 af of water under Article 21 and Solano received 8,095 af of non-SWP water.

Barker Slough Pumping Plant has a maximum pumping capacity of 160 cfs and is screened to exclude juvenile salmon from entrainment; however, the screens are not able to exclude the smaller Delta smelt. The amended Delta smelt opinion requires a reduction of diversions from Barker Slough to a 5-day running average of 65 cfs when Delta smelt under 20 millimeters are detected at three sites upstream of the plant. The running averages are calculated into a weighted average, with the weight of each station dependent upon the proximity to the Barker Slough pump intake. The opinion also set an estimated numerical loss limit at the

pumping plant during Delta smelt spawning season.

From February 15 to July 15, 2002, there were several occasions when the weighted average of Delta smelt entrainment, described in the amended Delta Smelt Biological Opinion, reached the level at which export reductions are required. These incidences occurred from March 29 to May 18, 2002 and either appropriate export reductions followed or, when viable data indicating the presence of Delta smelt was received, exports were already below the 5-day running average of 65 cfs.

Delta Water Management

South Delta Improvements Program

During the latter half of the 1990s, the Department sought to step up the construction of south Delta facilities to improve Delta water conditions. This was accomplished through the Interim South Delta Program. In 1999, the CALFED Bay-Delta Program decided to include south Delta facilities as a key component of the CALFED decision-making process. ISDP was subsequently renamed the *South Delta Improvements Program* and its purpose was revised to focus on the following issues:

(1) improve the reliability of existing SWP facilities;
(2) ensure that water of adequate quantity and quality is available for diversion to the South Delta Water Agency service area for beneficial use; and
(3) reduce the effects of SWP exports on both aquatic resources and direct losses of fish in the south Delta.

A preferred plan is being developed for SDIP as part of the ongoing process of preparing project-specific environmental documentation. The project will likely consist of the following:

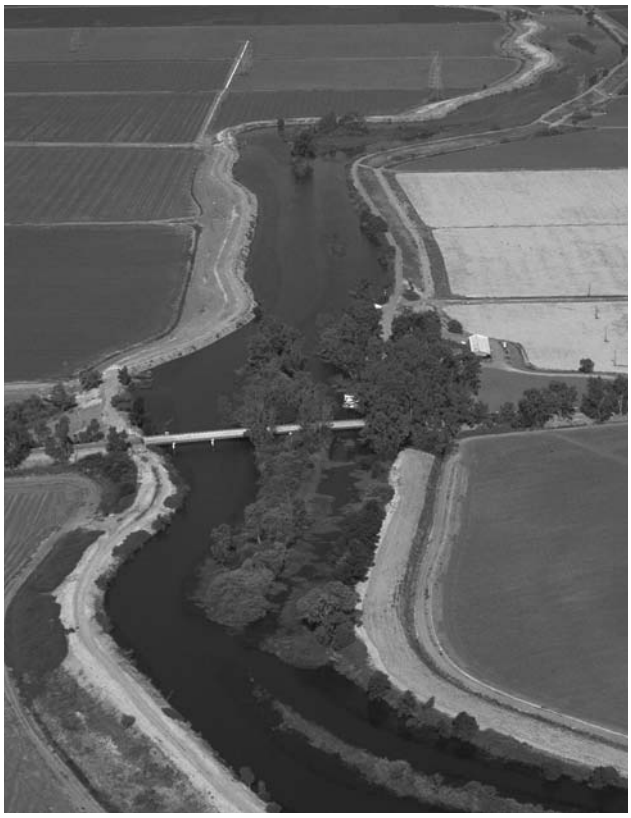
- three flow-control structures to improve local water levels in south Delta channels;
- a fish-control structure to improve fish migration in the San Joaquin River;
- some dredging in West Canal to improve conveyance capacity to Clifton Court Forebay;
- extensive dredging in the south Delta to improve channel capacity for local agricultural water users;
- modifications to existing agricultural diversion intakes; and
- increasing the maximum allowable diversion rate into Clifton Court Forebay to 8,500 cfs.

Clifton Court Forebay has a capacity of about 31 taf and provides water for off-peak pumping at nearby Banks Pumping Plant

Planning activities for increasing the SWP export limit to its maximum of 10,300 cfs are continuing; however, there are uncertainties regarding what technologies to apply and the identification of funding required for new intake and fish screening facilities at Clifton Court Forebay. The proposed project is a key component of the CALFED Conveyance Program. It would improve the reliability of SWP water supply and increase operational flexibility. In addition, the proposal to construct flow control structures in south Delta channels would allow the Department and the Bureau the ability to improve water levels for local agricultural diverters in the vicinity of the project export facilities. The flow control structures would also benefit both spring and fall salmon migrations in the San Joaquin River. The action to increase the maximum export limit to 8,500 cfs is scheduled for implementation in 2004.

South Delta Temporary Barriers Project

Since 1990, the Department has constructed seasonal barriers under the program's South Delta Temporary Barriers Project to improve south Delta water conditions and collect data for the design and operation of proposed permanent barriers. The temporary barriers have been placed across Middle River near Victoria Canal, Old River near Tracy, Grant Line Canal, and the Old River at Head (see Figure 4-13).



Middle River in the south Delta

The Old River at Head barrier prevents San Joaquin River flow from entering Old River and flowing toward SWP and CVP export facilities. The additional flow in the San Joaquin River downstream of Old River at Head is intended to guide juvenile salmon to the ocean in the spring and improves San Joaquin River dissolved oxygen levels for salmon migrating upstream in the fall to spawn.

The Department is obligated under the San Joaquin River Agreement, which facilitates the implementation of VAMP, to install and operate the spring Old River at Head fish barrier in a manner that will protect San Joaquin River Chinook salmon smolts and in conjunction with the flows provided during the pulse flow period. In spring 2002, the Old River at Head barrier was operational by April 18 and was removed by June 7. In the fall, the Old River at Head barrier was operational by October 4 and was breached on November 12. The removal of the barrier was completed on November 21, 2002.

The Middle River barrier is a temporary rock barrier installed near Victoria Canal, located about one-half mile south of the confluence of Middle River and Trapper Slough. This tidally-controlled barrier improves water circulation and water levels during the agricultural irrigation season. In 2002, the Middle River barrier was operational by April 15 and breached on November 20. The Middle River barrier was completely removed by November 23, 2002.

The Old River barrier near Tracy has been installed annually in spring since 1991. The barrier is installed on Old River, one-half mile east of the Tracy Pumping Plant. The Old River barrier near Tracy provides similar benefits to those of the Middle River barrier. In 2002, the Old River near Tracy barrier was operational by

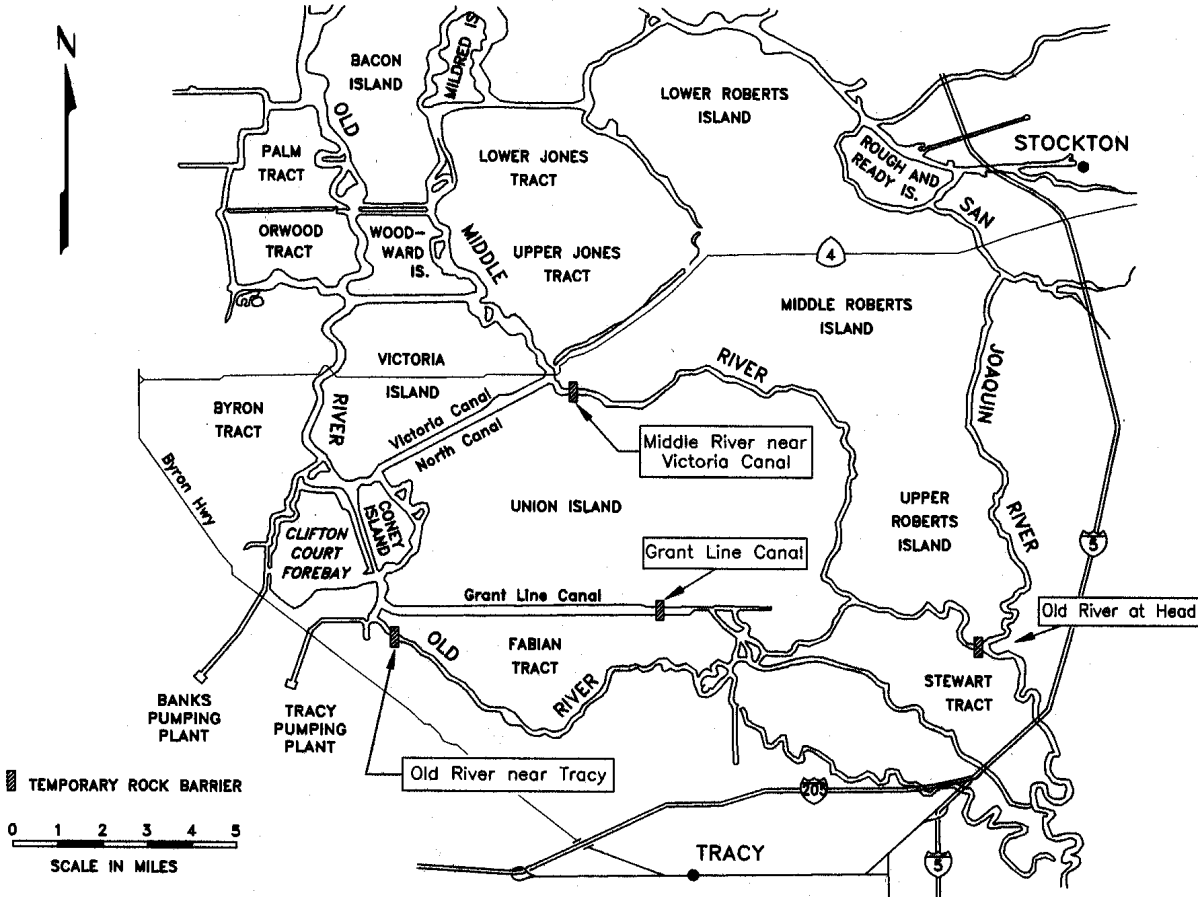


Figure 4-13. South Delta temporary barrier locations are shown.

April 18. The barrier was breached on November 16 and removal completed on November 29, 2002.

The Department began installing the Grant Line Canal barrier east of Tracy Boulevard Bridge in 1996. This barrier provides benefits similar to those of the Middle River barrier. In 2002, the Grant Line Canal barrier was operational by June 12. The barrier was breached on November 16 and removed completely by November 25, 2002 (Table 4-11).

Table 4-11. Dates of Installation and Removal of South Delta Temporary Barriers during 2002

Barriers	Installation Dates Completed	Removal Dates Completed
Middle River	April 15	November 23
Old River near Tracy	April 18	November 29
Old River at Head		
Spring barrier	April 18	June 7
Fall barrier	October 4	November 21
Grant Line Canal	June 12	November 25

5. Delta Water Quality Standards

Sacramento-San Joaquin Delta water quality is influenced by the quality and quantity of tributary inflows, regulated discharges, and agricultural drainage, including drainage from Delta islands, seawater intrusion into the Delta's western channels, and operations of the SWP and CVP. The SWP and CVP are required, under their SWRCB water right permits, to meet the water quality standards in SWRCB's D-1641, which is designed to protect the beneficial uses of Delta water.

Water quality standards and objectives are categorized by the beneficial uses they are intended to protect under broad categories that include municipal and industrial, agricultural, and fish and wildlife. The specific beneficial use coupled with the applicable water quality objectives make up the water quality standard.

The water quality compliance stations, including Suisun Marsh sites, are shown in Figure 5-1. The Department utilizes the following measures to meet D-1641 water quality and flow standards: (1) releases from upstream reservoirs; (2) operation of the Delta Cross Channel Gates; (3) Delta pumping operations; and (4) the construction of temporary rock barriers (see Chapter 4).

D-1641 incorporates the D-1422 San Joaquin River salinity standard at Vernalis. A dissolved oxygen objective for multiple locations on the San Joaquin River is contained within the 1995 Bay-Delta Water Quality Control Plan. The Plan also introduced a narrative objective for salmon protection and for the protection of brackish tidal marshes of Suisun Bay. Operational standards are summarized in Table 5-1.

Municipal and Industrial Objectives

D-1641 contains a municipal and industrial water quality objective based on mean daily chloride values which are set at several Delta export locations: Clifton Court Forebay, Tracy Pumping Plant, Contra Costa Canal Pumping Plant, Barker Slough, and Cache Slough. The Clifton Court Forebay is the start of the SWP California Aqueduct and Tracy Pumping Plant is the start of CVP Delta-Mendota Canal. The Contra Costa Canal Intake at Rock Slough is at the start of a supply canal that conveys water to eastern Contra Costa County. Cache Slough is an intake for the City of Vallejo. The Cache Slough standard was not in effect in 2002 because no water has been withdrawn from the site in several years. A mean daily chloride standard of not more than 250 mg/L was in effect for the entire 2002 calendar year at all the other export locations and was met at all stations with the exception of the Contra Costa Canal Pumping Plant which exceeded the objective eight times in October (Figure 5-2).

D-1641 contains an additional municipal and industrial objective requiring that chloride not exceed 150 mg/L for a specified number of days accrued in intervals of at least 2 weeks, at the better of two stations, either the Contra Costa Canal Pumping Plant or the Antioch Water Works Intake. The percentage of days in the calendar year required by this standard is a function of water year type. It varies between 42 and 66 percent of the year, becoming less stringent under drier conditions. The dry-year 165-day (45 percent of the year) criterion was met at the Contra Costa Canal Pumping Plant on June 14, 2002.

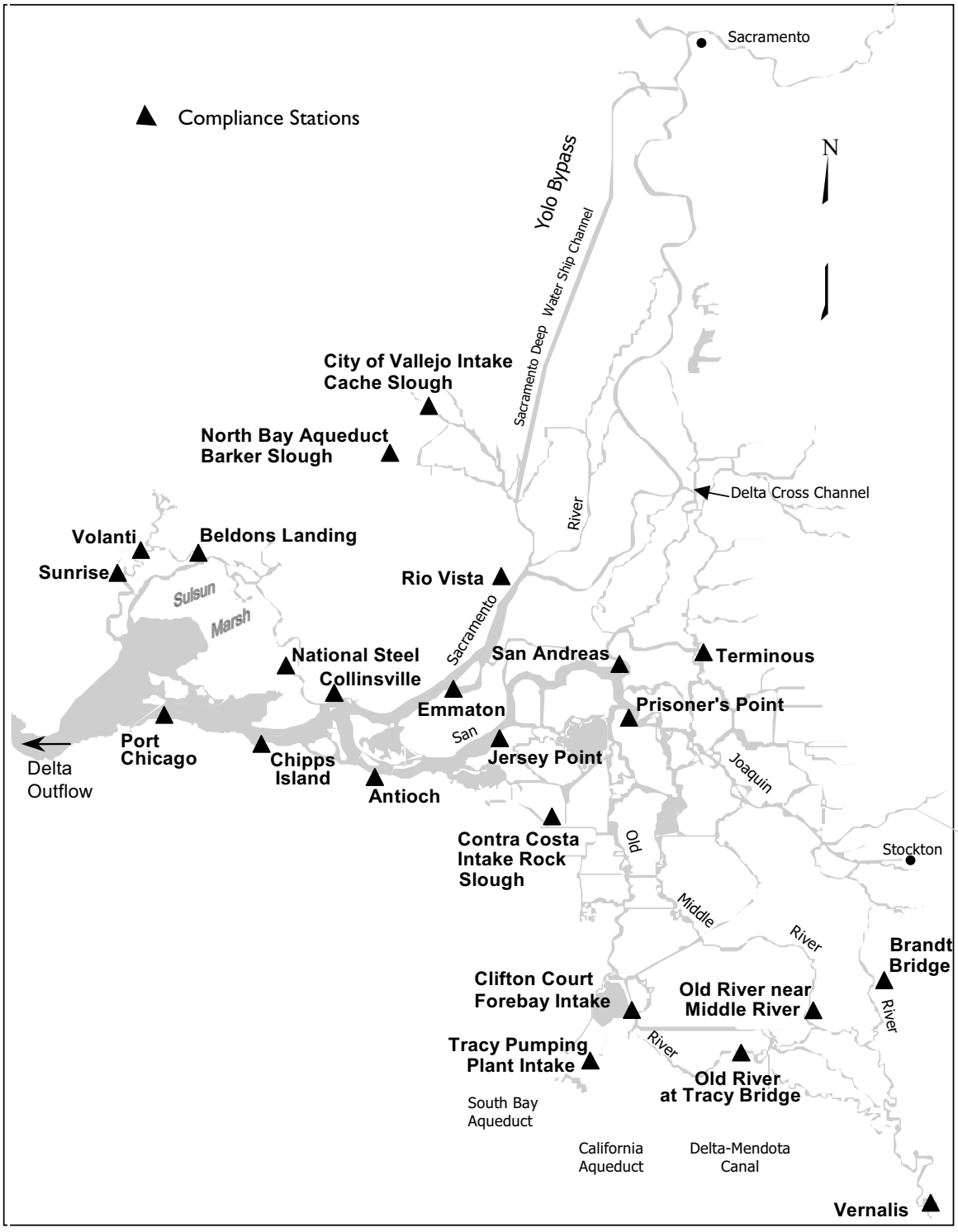


Figure 5-1. D-1641 water quality compliance locations in the Sacramento-San Joaquin Delta

Table 5-1. D-1641 Dry Year Water Quality Standards for the Sacramento-San Joaquin Delta during 2002

Compliance Location	Standard	
	Municipal and Industrial	
Contra Costa Canal Intake, Clifton Court Forebay, Tracy Pumping Plant, Contra Costa Canal Intake, Barker Slough Pumping Plant, and Cache Slough Vallejo Intake	md CL <250	All months
Contra Costa Canal Intake or Antioch Water Intake	daily CL <150	165 days in the year
	Agricultural	
Western and Interior Delta		
Emmaton and Jersey Point	14 dm EC <0.45	April 1- June 15
Emmaton	14 dm EC <1.67	June 15-August 15
Jersey Point	14 dm EC <1.35	June 15-August 15
Terminous	14 dm EC <0.45	April 1-August 15
San Andreas Landing	14 dm EC <0.45	April 1-June 25
	14 dm EC <0.58	June 25-August 15
Southern Delta		
San Joaquin River at Vernalis	30 dm EC <0.7	April-August
	30 dm EC <1.0	September-March
San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridges	30 dm EC <1.0	April-August
	30 dm EC <1.0	September-March
Export Area		
Clifton Court Forebay and Tracy Pumping Plant	mm EC <1.0	all months
	Fish and Wildlife	
Dissolved Oxygen[a]		
San Joaquin River between Turner Cut and Stockton	DO >6.0	September-November
San Joaquin River Salinity		
Jersey Point to Prisoner's Point	14 dm EC <0.44	April-May
Habitat Protection Salinity Starting Condition February starting salinity: - If January 8-River Index >900 taf, then the daily or 14-day running average EC at Collinsville ≤2.64 mS/cm for at least 1 day between February 1-14. - If January 8-River Index is between 650 TAF and 900 TAF, then the CALFED Operations Group will determine if this requirement must be met. See Table 5-3 for determination of compliance of 2.64 mS/cm at Chipps Island or Port Chicago.		
Suisun Marsh (see Table 5-4)		

Note: DO: dissolved oxygen (mg/L); CL: chlorides (mg/L); EC: electrical conductivity (mS/cm); md: mean daily; 30 dm: 30-day running mean; 14 dm: 14-day running mean; mm: mean monthly; 28 dm: 28-day running mean.

[a]Dissolved oxygen objective is contained in SWRCB's 1995 Bay-Delta Plan.

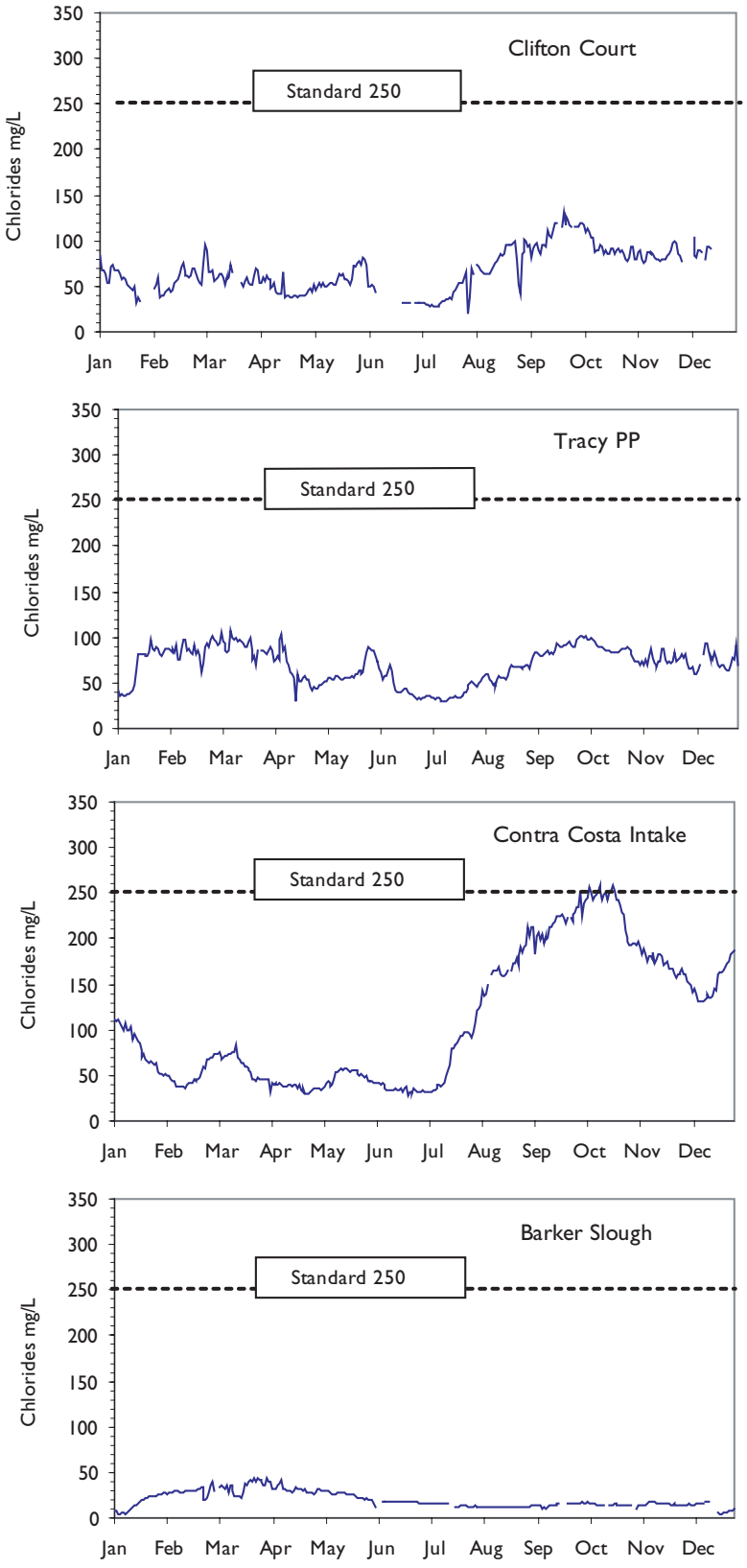


Figure 5-2. Municipal and industrial water quality standards in 2002

Agricultural Objectives

Agricultural EC objectives are contained within D-1641 to protect Delta agriculture during the irrigation season, from April 1 to August 15. Compliance locations in the western Delta include Emmaton and Jersey Point, with San Andreas Landing and Terminous in the interior Delta. Additional year-round compliance locations in the southern Delta are at Vernalis and Brandt Bridge. During September and October the compliance locations are near the export areas at Clifton Court Forebay and Tracy Pumping Plant. When hydrologic conditions are drier than average, the objectives are relaxed during the latter part of the irrigation season to reflect the water quality that would have occurred in the absence of the SWP and CVP. Under critical-year conditions, the objectives are relaxed for the entire growing season to reflect salinity intrusions expected with lower basin runoff into the Delta. The agricultural water quality objective is set as a maximum 14-day running average EC for Emmaton, Jersey Point, Terminous, and San Andreas Landing. The dry-year EC objectives are as follows:

- at Emmaton—the objective is 0.45 mS/cm from April 1 through June 14 and then 1.67 mS/cm from June 15 through August 15.
- at Jersey Point—the objective also requires an EC of 0.45 mS/cm from April 1 through June 14 but then 1.35 mS/cm from June 15 through August 15.
- Mokelumne River at Terminous—the objective requires an average 0.45 mS/cm from April 1 through August 15.
- San Andreas Landing on the San Joaquin River—the objective is set at 0.45 mS/cm April 1 through June 24 and 0.58 mS/cm June 25 through August 15.

The Vernalis agricultural objective, based on a 30-day running average, is set at 0.70 mS/cm from April-August and rises to 1.0 mS/cm September-March. Three other southern Delta agricultural salinity requirements are listed in D-1641 for the San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River near Tracy Road Bridge. These three locations are required to maintain EC at or below 1.0 mS/cm for the entire year. There is also a year-round EC requirement of 1.0 mS/cm (maximum monthly average) for export areas,

Aerial view of Delta agriculture and water channels

namely, Clifton Court Forebay and Tracy Pumping Plant (Figures 5-3, 5-4, and 5-5).

The responsibility for meeting standards and objectives is generally apportioned under COA to be met by the Department and the Bureau, with the exception of the San Joaquin River agricultural EC objectives at Vernalis and Brandt Bridge. These agricultural objectives are the expressed responsibility of the Bureau, since the Department does not regulate any reservoirs upstream of the San Joaquin River. During 2002, the Department met all standards for which it has responsibility under COA and SWRCB, with the exception of the Contra Costa Canal Pumping Plant chloride objective, as stated previously. The Department also has an obligation to maintain water quality for agricultural uses under the 1981 North Delta Water Agency contract, as amended.

Fish and Wildlife Objectives

D-1641 contains several water quality objectives for the protection of Delta fish and wildlife.

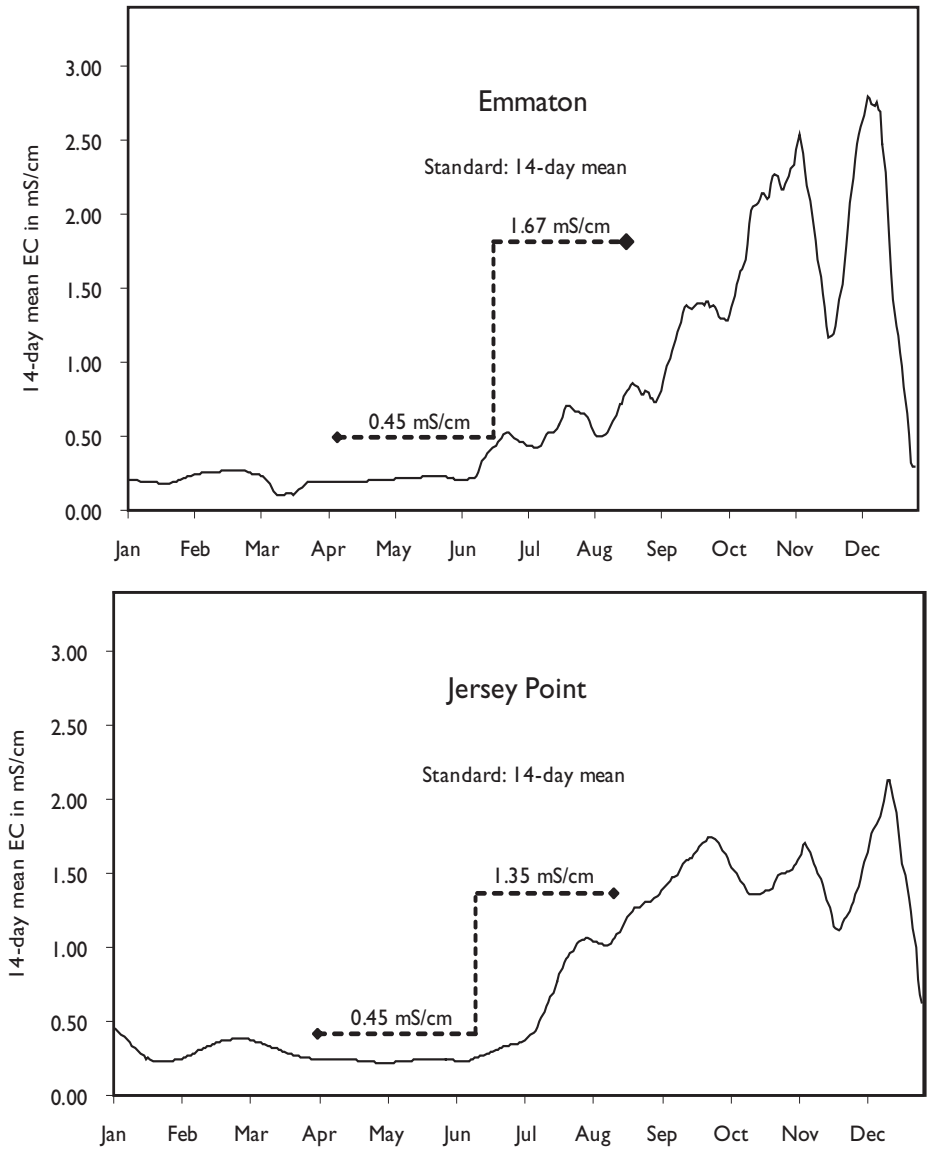


Figure 5-3. Dry-year agricultural water quality standards in the western Delta in 2002

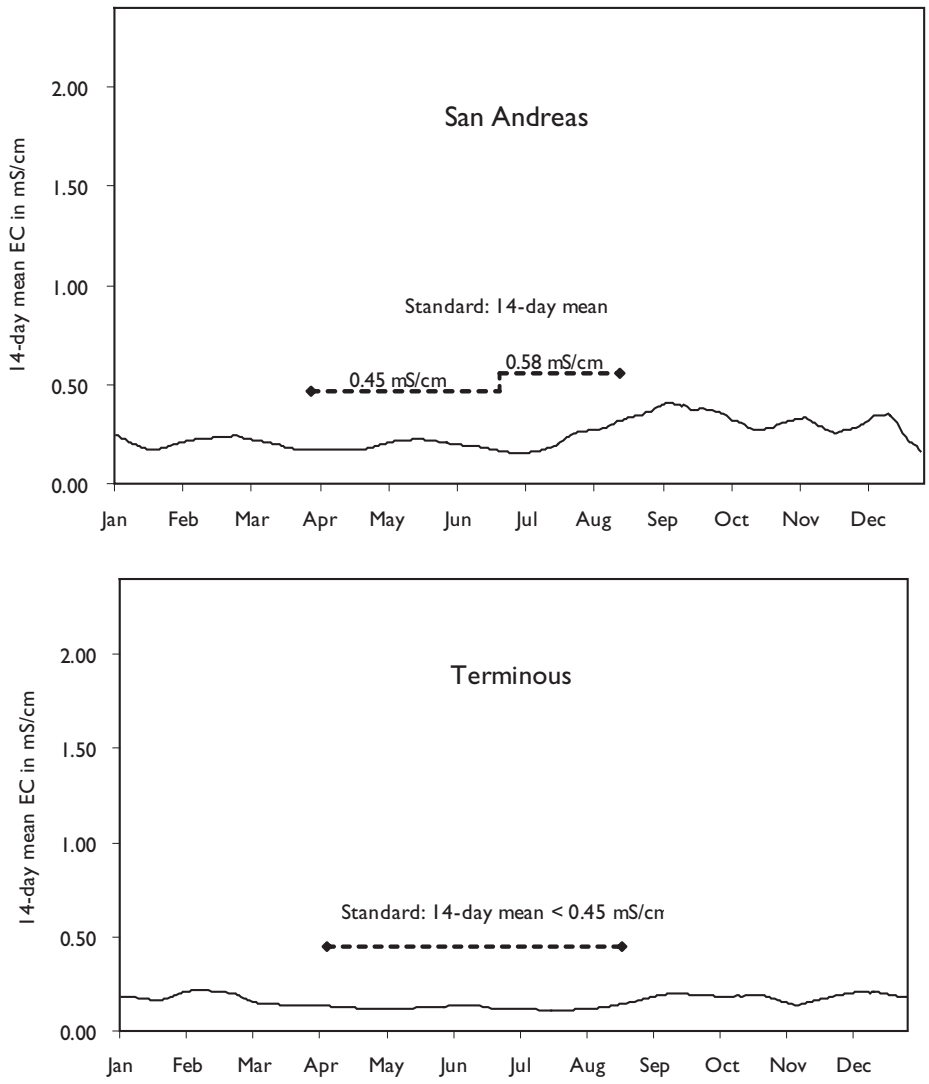


Figure 5-4. Dry-year agricultural water quality standards in the interior Delta in 2002

These include a water quality objective for EC on the San Joaquin River measured between Jersey Point and Prisoner's Point and at several locations in the Suisun Marsh. Suisun Marsh standards are discussed below in the Suisun Marsh Protection Plan and Preservation Agreement section. Other standards combining both EC and flow were set to protect the estuarine habitat in the Suisun Bay area. The San Joaquin River dissolved oxygen objective was carried over from D-1422 to the 1995 Bay-Delta Plan. All of these measures were established in part to encourage spawning and survival of striped bass and to protect migrating salmon.

San Joaquin River Salinity Objective

The Jersey Point and Prisoner's Point objective is set as a maximum 14-day running mean of 0.44 mS/cm during April and May to protect striped bass spawning habitat. Compliance with the Prisoner's Point EC standard is actually measured at San Andreas Landing, which provides a conservative estimate due to its location west of Prisoner's Point. During the April 1 through May 31 compliance period, Jersey Point values averaged 0.24 mS/cm and never exceeded 0.26 mS/cm and at San Andreas Landing averaged 0.20 mS/cm and never exceeded 0.23 mS/cm.

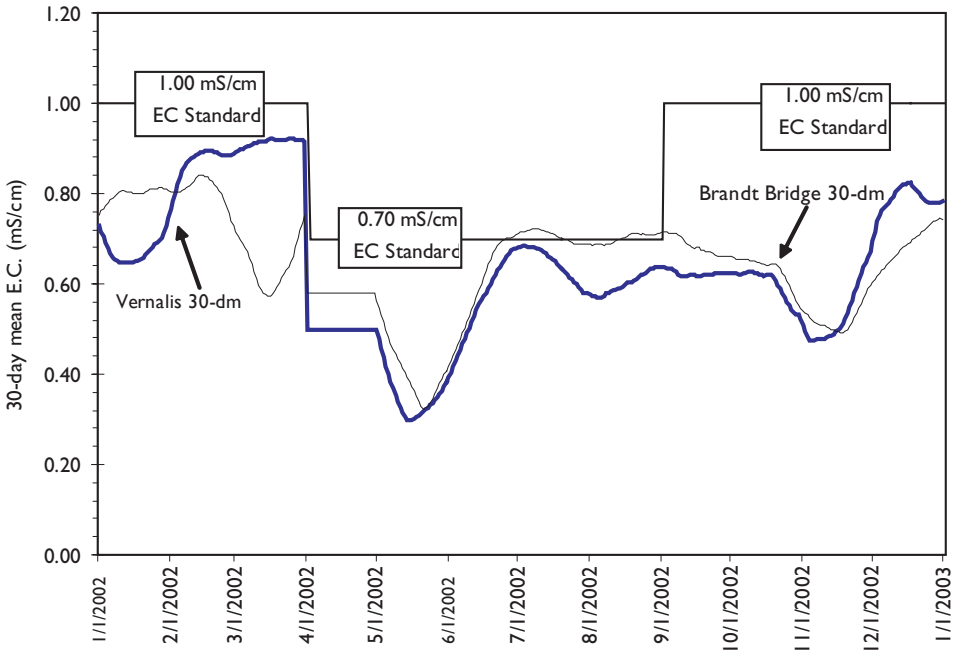


Figure 5-5. San Joaquin River EC standards in 2002. The 30-day running average resets on April 1 and September 1 to allow for the change in the standard. Compliance with the EC standard at Brandt Bridge will be required to meet the 0.07 mS/cm standard on April 1, 2005. Until that time the standard will be 1.0 mS/cm from April 1 through August 30.

Dissolved Oxygen Objective

The 1995 Bay-Delta Plan includes a dissolved oxygen objective for the lower San Joaquin River similar to, but more stringent than, the DO standard included in D-1422. DO levels are required to be at least 6.0 mg/L during September through November. During late summer and early fall each year, DO concentrations in the Stockton Ship Channel are closely monitored because they can deteriorate to critially low levels (<5.0 mg/L). DO is measured at 14 sites, at the water surface and at the channel bottom, between Prisoner's Point and the Stockton Deep Water Channel Turning Basin. Low DO levels have the potential to cause physiological stress to fish and block the upstream migration of salmon.

Low oxygen conditions may result from many factors—low stream inflows, intermittent reverse-flow conditions in the San Joaquin River past Stockton, warm water temperatures, reduced tidal mixing, and high biochemical oxygen demand levels as the result of regulated discharges in the Stockton area and recreational activity adjacent to the basin. The Department's Operation Control Office monitors DO in the Stockton Ship Channel as the basis for some operational decisions. The fall installation of the Old River at Head barrier is a commonly used remedy for low DO conditions in the lower San Joaquin River. The barrier increases net flows down the San Joaquin River past Stockton, helping to improve dissolved oxygen levels, particularly in the eastern channel.

During August and September, San Joaquin River flows at Vernalis were relatively low ranging from 1,000 to 1,626 cfs. The Old River at Head barrier was installed on October 4, in response to the low San Joaquin River flows at and projected fall flows which would be insufficient to alleviate low DO conditions in the eastern channel. The barrier remained in place until November 15. During this 5-week period, DO levels were generally high in all channel regions.

The Department's Division of Operations and Maintenance commissioned a DO concentration study in the Stockton Ship Channel that included nine DO concentration monitoring runs conducted by vessel from July 23 to December 18.

Because monitoring results differ within the channel, sampling stations were grouped into western, central, and eastern regions. The western channel begins at Prisoner's Point and ends at Columbia Cut. The central channel begins a half-mile east of Columbia Cut and ends at Fourteen Mile Slough. Lastly, the eastern Channel begins at Buckley Cove and ends at Rough and Ready Island. The Turning Basin is unique within the channel because it is located east of the entry point of the San Joaquin River into the channel and isolated from down-channel flow.

During this study, DO levels varied considerably between regions within the channel. DO concentrations in the western channel were relatively high and stable and ranged from 7.0-10.0 mg/L during the July 23 to December 18 study. These high DO levels were likely due to greater tidal mixing, the absence of conditions that create biochemical oxygen demand, and shorter hydrological residence times as compared to upstream regions.

Low DO levels occurred in both the central and eastern channel regions. In the central channel, DO concentrations fell below 5.0 mg/L throughout much of September and during October. In the eastern channel, DO levels were low in August and September but were more variable and stratified in October. DO levels ranged from a low of 3.3 mg/L in September to a high of 10.8 mg/L in October. Changing inflows from the San Joaquin River into the eastern channel may partially account for the variability of the DO levels within the eastern channel.

The Old River at Head barrier was removed on November 15 due to improved DO conditions and the anticipation of increased San Joaquin River flows. The barrier's removal coincided with an immediate return to low DO conditions in the eastern channel. Decreased inflows into the channel appear to have contributed to DO levels below 5.0 mg/L within the eastern channel during November.

During the first half of December, the relatively low inflows to the channel continued. On December 3, DO levels in the eastern channel

The Sacramento-San Joaquin Delta is a maze of more than 700 miles of sloughs and waterways.

were exceptionally low, dropping to 3.3 mg/L. In the central channel DO conditions were good, similar to those on late November, with DO levels between 5.0 mg/L and 6.0 mg/L only occurring at Fourteen Mile Slough.

San Joaquin River flows past Stockton coupled with cooler water temperatures may have contributed to the slightly improved DO concentrations measured in the eastern channel on December 18, where DO levels averaged 5.7 mg/L. Due to improving conditions, the 2002 DO special studies were terminated on December 18 (Figure 5-6).

Estuarine Habitat Protection Objective (X2)

D-1641 includes an estuarine habitat protection objective that incorporates a modified X2 criteria (geographic isohaline), first established in the 1994 Delta Smelt Biological Opinion. Delta outflow is used to maintain the position of 2-ppt isohaline (2 parts per thousand of salt in the water), measured as 2.64 mS/cm on the water's surface at Collinsville, Chipps Island, or Port Chicago during February through June. This location of the required isohaline is associated with fish and biota abundance.

The number of days per month when the daily averaged EC maximum (2.64 mS/cm) is in effect at Chipps Island and Port Chicago, is conditioned by the previous month's Eight River Index and is noted in Table 4 of D-1641 (Table 5-2). Collinsville is the default location for X2 where EC must average 2.64 mS/cm or less for the entire month. The Port Chicago standard is usually in effect during months when the Port Chicago 14-day EC average immediately prior to the first day of the month is less than or equal to 2.64 mS/cm. If salinity or flow requirements are met for a greater number of days than

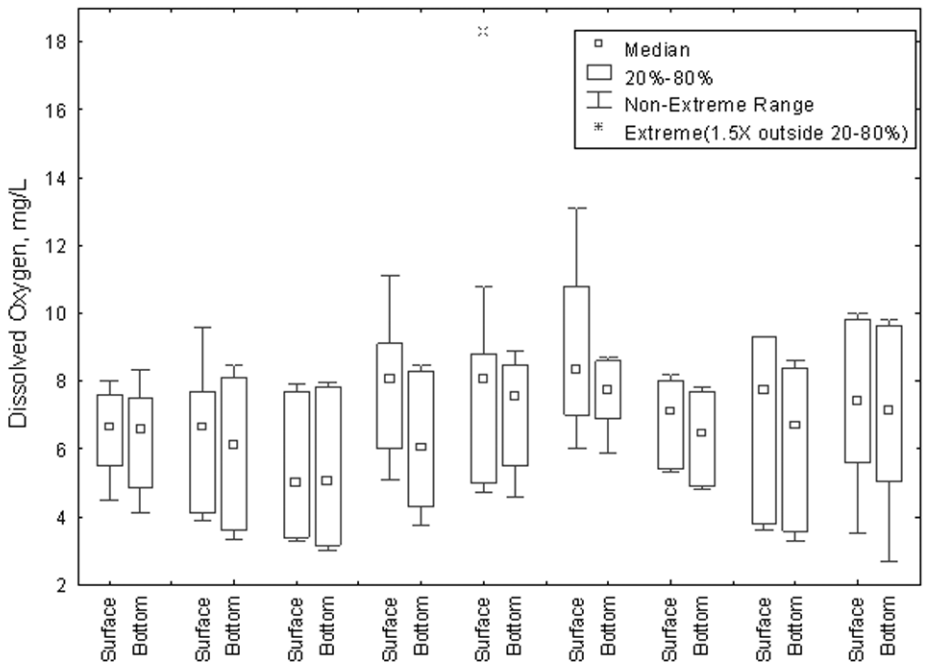


Figure 5-6. Dissolved oxygen concentration in the Stockton Ship Channel during 2002

Table 5-2. D-1641 Table 4: Habitat Protection Outflow

Chipps Island					
PMI (taf)	*Feb*	*Mar*	*Apr*	*May*	*Jun*
500	0	0	0	0	0
750	0	0	0	0	0
1,000	28[a]	12	2	0	0
1,250	28	31	6	0	0
1,500	28	31	13	0	0
1,750	28	31	20	0	0
2,000	28	31	25	1	0
2,250	28	31	27	3	0
2,500	28	31	29	11	1
2,750	28	31	29	20	2
3,000	28	31	30	27	4
3,250	28	31	30	29	8
3,500	28	31	30	30	13
3,750	28	31	30	31	18
4,000	28	31	30	31	23
4,250	28	31	30	31	25
4,500	28	31	30	31	27
4,750	28	31	30	31	28
5,000	28	31	30	31	29
5,250	28	31	30	31	29
5,500	28	31	30	31	30

Port Chicago					
PMI (taf)	*Feb*	*Mar*	*Apr*	*May*	*Jun*
0	0	0	0	0	0
250	1	0	0	0	0
500	4	1	0	0	0
750	8	2	0	0	0
1,000	12	4	0	0	0
1,250	15	6	1	0	0
1,500	18	9	1	0	0
1,750	20	12	2	0	0
2,000	21	15	4	0	0
2,250	22	17	5	1	0
2,500	23	19	8	1	0
2,750	24	21	10	2	0
3,000	25	23	12	4	0
3,250	25	24	14	6	0
3,500	25	25	16	9	0
3,750	26	26	18	12	0
4,000	26	27	20	15	0
4,250	26	27	21	18	1
4,500	26	28	23	21	2
4,750	27	28	24	23	3
5,000	27	28	25	25	4
5,250	27	29	25	26	6
5,500	27	29	26	28	9
5,750	27	29	27	28	13
6,000	27	29	27	29	16
6,250	27	30	27	29	19
6,500	27	30	28	30	22
6,750	27	30	28	30	24
7,000	27	30	28	30	26
7,250	27	30	28	30	27
7,500	27	30	29	30	28
7,750	27	30	29	31	28
8,000	27	30	29	31	29
8,250	28	30	29	31	29
8,500	28	30	29	31	29
8,750	28	30	29	31	30
9,000	28	30	29	31	30
9,250	28	30	29	31	30
9,500	28	31	29	31	30
9,750	28	31	29	31	30
10,000	28	31	30	31	30
10,000	28	31	30	31	30

[a]When 800 taf <PMI.

Note: Number of days when maximum daily average EC 2.64 mS/cm must be maintained. (This can also be met with maximum 14-day running average EC of 2.64 mS/cm, or 3-day running average Delta outflows of 11,400 cfs and 29,200 cfs, respectively.) Port Chicago standard is triggered only when the 14-day average EC for the last day of the previous month is 2.64 mS/cm or less. PMI is previous month's 8-RI. If salinity/flow objectives are met for a greater number of days than required for any month, the excess days shall be applied towards the following month's requirement. The number of days or values of the PMI between those specified below shall be determined by linear interpolation.

required for any month, the excess days are applied to meeting the requirements for the following month if X2 is required to be at the same location.

The daily average EC requirement for X2 may be alternately met with a 14-day running average of EC of 2.64 mS/cm or less at the three locations, or a flow alternative set as a 3-day running average of NDOI for the required number of days. The NDOI requirement is set at 7,100 cfs, 11,400 cfs, and 29,200 cfs when the X2 is located at Collinsville, Chipps Island, and Port Chicago, respectively. The previous month's Eight River Index for February through June, 2002, was 2.70 maf, 1.74 maf, 2.31 maf, 2.82 maf, and 2.60 maf, respectively. During 2002, X2 was met at Chipps Island from February through June. Referencing Table 4 in D-1641, the number of days of compliance required for maintaining a maximum EC of 2.64 mS/cm at Chipps Island was 28 days for February. For March, April, May, and June, days required for X2 at Chipps Island were 31, 28, 22, and 1, respectively.

The X2 Habitat Protection objective at Chipps Island during February 2002 was met with a combination of days with 3-day mean of NDOI greater than 11,400 cfs and days with EC below 2.64 mS/cm. From March through June, the X2 objective was met at Chipps Island with both 14-day and daily average of EC below 2.64 mS/cm (Table 5-3).

Suisun Marsh Protection Plan and Preservation Agreement

The Suisun Marsh, comprising 89,000 acres located in southern Solano County, provides one of the largest estuarine waterfowl habitats in the continental United States and represents more than 10 percent of California's remaining

Table 5-3. Determination of Habitat Protection Compliance during 2002

		Compliance					
Month	**PMI[a]**	*Location*	*Required Days*	**Days Met**	**Carryover Days[b]**	**Criteria Used to Meet Objective[c]**	**Criteria for Meeting Standard (days met)**
Feb	2.70	Chipps Island	28	28	0	3-dm of NDOI>11,400cfs daily mean of EC 14-day mean of EC	10 18 20
Mar	1.74	Chipps Island	31	31	0	3-dm of NDOI>11,400 cfs daily mean of EC 14-day mean of EC	31 31 31
Apr	2.31	Chipps Island	28	30	2	3-dm of NDOI>11,400 cfs daily mean of EC 14-day mean of EC	16 31 31
May	2.82	Chipps Island	22	31	9	3-dm of NDOI>11,400 cfs daily mean of EC 14-day mean of EC	18 28 31
Jun	2.60	Chipps Island	1	11		3-dm of NDOI>11,400 cfs daily mean of EC 14-day mean of EC	 6 11

Note: Shaded area describes which criteria were used to meet compliance days and how many days of each were met.

[a]PMI - Previous month's Eight River Index in maf.

[b]Carryover days may be used to meet the next month's requirement, if at the same compliance location.

[c]Compliance may be met using either daily EC, 14-dm EC <2.64 mS/cm or specific 3-dm of NDOI.

natural wetlands. The marsh also provides resting and feeding grounds for thousands of waterfowl migrating on the Pacific Flyway.

Suisun Marsh water quality has been protected since 1971, first through SWRCB's D-1379 and later in 1978 by the adoption of D-1485. In 1987, the Department signed the Suisun Marsh Preservation Agreement in conjunction with the Bureau, DFG, and the Suisun Resources Conservation District, which represents private landowners. In 1995, SWRCB WR 95-06 eliminated the Chipps Island running 28-day salinity average standard and the Eastern Marsh standard at Mallard Slough. WR 95-06 added a new narrative objective for the brackish tidal marshes of Suisun Bay to protect remnant tidal marshes and changed the compliance date for two western Suisun Marsh stations, S-35 and S-97, to October 1997. SWRCB granted extensions three times, pushing the compliance requirement to November 1, 1999. D-1641 converted these two western marsh stations to monitoring stations, dropping the compliance requirements at both locations.

The Suisun Marsh Salinity Control Gates began operating in 1989 during the control season (from October 1 to May 31) and are operated only as needed to meet D-1641 salinity standards. The gates, located 2 miles downstream from Collinsville in Montezuma Slough, respond to daily tidal fluctuations, opening to admit fresher flow from the Sacramento River and closing to block tidal salt-water intrusion from Suisun Bay. The gates are considered to be in full operation when all three gates are tidally operated, the flashboards have closed off the maintenance channel, and the boat lock is operational.

During the 2001-2002 salinity control season (October 2001 through May 2002), the salinity control gates were operated for both a salmon passage study and for salinity control. The fall 2001 salmon passage study was conducted using the modified boat lock operations as an alternative for fish passage.

For the first seven days in October 2001 the gates were held open with the flashboards installed due to good water quality in the marsh and because the first phase of the salmon passage study did not require operation of the gates. From October 8 through October 21, 2001, Phase 2 of the salmon study was conducted, requiring full-bore operations of the gates with flashboards installed, and boat lock gates open.

USFWS biologists remove salmon from a fyke trap for fork length measurement.

Phase 3 began on October 22 and ran through November 5, 2001. Phase 3 was conducted with full-bore operations, flashboards installed and the boat lock closed. Gate # 3 of the salinity control structure malfunctioned during Phase 3 of the salmon study and remained stuck closed from October 26 through November 2. The salmon study was able to continue despite the malfunction. Following the end of the salmon study on November 5, 2001, the gates continued to operate normally for salinity control. On January 17, 2002, favorable water quality conditions allowed the gates to be held open with the flashboards left in place, in case they were needed. On May 26, 2002, the flashboards were removed since water quality was no longer threatened for the balance of the salinity control season.

All Suisun Marsh salinity standards were met during 2002 (Table 5-4).

Bay-Delta Plan Brackish Tidal Marshes of Suisun Bay Narrative Objective

The Bay-Delta Plan's narrative water quality objective for brackish tidal marsh protection is stated as:

> *Water quality sufficient to support a natural gradient on species composition and wildlife habitat characteristic of a brackish marsh throughout all elevations of the tidal marshes bordering Suisun Bay shall be maintained. Water quality conditions shall be maintained so that none of the following occurs: (a) loss of diversity; (b) conversion of brackish marsh to salt marsh; (c) for animals, decreased population abundance of those species vulnerable to increased mortality and loss of habitat from increased water salinity; or (d) for plants, significant reduction in stature or percent cover from increased water or soil salinity or other water quality parameters.*

SWRCB determined that implementation of Bay-Delta Plan numerical objectives, particularly NDOI, would achieve the narrative objective. The Suisun Marsh Ecological Workgroup completed its final report and submitted to SWRCB in late 2001. The SEW recommendations, included in the report, are currently under review by SWRCB. More information on the Suisun Marsh is available in Department Bulletin in 132-03, Chapter 4.

Western Delta Municipal and Industrial Users Agreements

Several contracted water quality standards are in effect for western Delta municipal and industrial water users that predate D-1485 and subsequent water rights decisions and plans. Under agreements with both municipal and industrial contractors, loss of offshore water is compensated for by substitute water supplies, net credit balances for days of above-average water, or monetary payment.

The Department contracted with the Contra Costa Water District in 1967 and with the City of Antioch in 1968 to assure the water district and the city would be compensated for costs associated with the loss of usable offshore Delta water supplies resulting from SWP operations. Credit for the number of days of above-average offshore water supplies of sufficient quality is accrued to offset the number of below-average days in future years. Contra Costa's standard is for 142 days and Antioch's is 208 days of usable water. During water year 2002, a usable Delta water supply was available to Antioch throughout the period of standard and no compensation payments were necessary. Contra Costa Water District was in deficit of 106 usable water days at the Mallard Slough intake (after a credit of 9 days from 2001) and the Department was required to pay $283,649 in compensation.

Table 5-4. D-1641 Suisun Marsh Salinity Standards in Effect during 2002

Month	Standard MHTEC[a]	Actual MHTEC				
		C-2 Collinsville	*S-64 National Steel*	*S-49 Beldons Landing*	*S-42 Volanti*	*S-21 Sunrise Club*
			Fourteenth Control Season			
January	12.5	0.3	0.5	1.1	1.6	1.5
February	8.0	0.9	3.3	4.2	4.8	4.6
March	8.0	0.5	3.4	5.5	5.5	5.5
April	11.0	0.6	2.6	4.5	4.6	4.5
May	11.0	1.0	3.0	5.1	5.3	5.5
		9.1	*Fifteenth Control Season*			
October	19.0	8.5	8.6	11.1	13.5	13.4
November	15.5	8.7	8.4	10.1	11.4	11.9
December	15.5	9.1	9.2	9.6	11.0	10.2

Note: Additional stations S-35 and S-97 converted to monitoring stations with the adoption of D-1641.

[a]MHTEC - Monthly average of both daily high-tide ECs in mS/cm.